

Test Report

Report No. : CQASZ20230200214E-01
Applicant: Shenzhen TANGMAI Technology Co., Ltd.
Address of Applicant: 502, No.2 Makan South Road, Xili Town, Nanshan District, Shenzhen, Guangdong, China

Equipment Under Test (EUT):

Product: TONEMAC Q1 Open-Ear True Wireless Earbuds
Model No.: TONEMAC Q1
Test Model No.: TONEMAC Q1
Brand Name: TONEMAC
FCC ID: 2A6XE-Q1
Standards: 47 CFR Part 15, Subpart C
Date of Receipt: 2023-02-24
Date of Test: 2023-02-24 to 2023-03-09
Date of Issue: 2023-03-27
Test Result : **PASS***

*In the configuration tested, the EUT complied with the standards specified above.

Tested By: Lewis Zhou
(Lewis Zhou)

Reviewed By: Timo Lei
(Timo Lei)

Approved By: Jack Ai
(Jack Ai)



1 Version

Revision History Of Report

Report No.	Version	Description	Issue Date
CQASZ20230200214E-01	Rev.01	Initial report	2023-03-27

2 Test Summary

Test Item	Test Requirement	Test method	Result
Antenna Requirement	47 CFR Part 15, Subpart C Section 15.203/15.247 (c)	ANSI C63.10 (2013)	PASS
AC Power Line Conducted Emission	47 CFR Part 15, Subpart C Section 15.207	ANSI C63.10 (2013)	PASS
Conducted Peak Output Power	47 CFR Part 15, Subpart C Section 15.247 (b)(1)	ANSI C63.10 (2013)	PASS
20dB Occupied Bandwidth	47 CFR Part 15, Subpart C Section 15.247 (a)(1)	ANSI C63.10 (2013)	PASS
Carrier Frequencies Separation	47 CFR Part 15, Subpart C Section 15.247 (a)(1)	ANSI C63.10 (2013)	PASS
Hopping Channel Number	47 CFR Part 15, Subpart C Section 15.247 (a)(1)	ANSI C63.10 (2013)	PASS
Dwell Time	47 CFR Part 15, Subpart C Section 15.247 (a)(1)	ANSI C63.10 (2013)	PASS
Pseudorandom Frequency Hopping Sequence	47 CFR Part 15, Subpart C Section 15.247(b)(4)	ANSI C63.10 (2013)	PASS
Band-edge for RF Conducted Emissions	47 CFR Part 15, Subpart C Section 15.247(d)	ANSI C63.10 (2013)	PASS
RF Conducted Spurious Emissions	47 CFR Part 15, Subpart C Section 15.247(d)	ANSI C63.10 (2013)	PASS
Radiated Spurious emissions	47 CFR Part 15, Subpart C Section 15.205/15.209	ANSI C63.10 (2013)	PASS
Restricted bands around fundamental frequency (Radiated Emission)	47 CFR Part 15, Subpart C Section 15.205/15.209	ANSI C63.10 (2013)	PASS

3 Contents

	Page
1 VERSION	2
2 TEST SUMMARY	3
3 CONTENTS	4
4 GENERAL INFORMATION	5
4.1 CLIENT INFORMATION	5
4.2 GENERAL DESCRIPTION OF EUT	5
4.3 ADDITIONAL INSTRUCTIONS	7
4.4 TEST ENVIRONMENT	8
4.5 DESCRIPTION OF SUPPORT UNITS	8
4.6 STATEMENT OF THE MEASUREMENT UNCERTAINTY	9
4.7 TEST LOCATION	10
4.8 TEST FACILITY	10
4.9 ABNORMALITIES FROM STANDARD CONDITIONS	10
4.10 OTHER INFORMATION REQUESTED BY THE CUSTOMER	10
4.11 EQUIPMENT LIST	11
5 TEST RESULTS AND MEASUREMENT DATA	12
5.1 ANTENNA REQUIREMENT	12
5.2 CONDUCTED EMISSIONS	13
5.3 CONDUCTED PEAK OUTPUT POWER	17
5.4 20dB OCCUPY BANDWIDTH	24
5.5 CARRIER FREQUENCIES SEPARATION	30
5.6 HOPPING CHANNEL NUMBER	34
5.7 DWELL TIME	37
5.8 BAND-EDGE FOR RF CONDUCTED EMISSIONS	48
5.9 SPURIOUS RF CONDUCTED EMISSIONS	56
5.10 OTHER REQUIREMENTS FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM	71
5.11 RADIATED SPURIOUS EMISSION & RESTRICTED BANDS	73
5.11.1 Radiated Emission below 1GHz	76
5.11.2 Transmitter Emission above 1GHz	78
6 PHOTOGRAPHS - EUT TEST SETUP	81
6.1 RADIATED EMISSION	81
6.2 CONDUCTED EMISSION	82
7 PHOTOGRAPHS - EUT CONSTRUCTIONAL DETAILS	83

4 General Information

4.1 Client Information

Applicant:	Shenzhen TANGMAI Technology Co., Ltd.
Address of Applicant:	502, No.2 Makan South Road, Xili Town, Nanshan District, Shenzhen, Guangdong, China
Manufacturer:	Shenzhen TANGMAI Technology Co., Ltd.
Address of Manufacturer:	502, No.2 Makan South Road, Xili Town, Nanshan District, Shenzhen, Guangdong, China
Factory:	Shenzhen TANGMAI Technology Co., Ltd.
Address of Factory:	502, No.2 Makan South Road, Xili Town, Nanshan District, Shenzhen, Guangdong, China

4.2 General Description of EUT

Product Name:	TONEMAC Q1 Open-Ear True Wireless Earbuds
Model No.:	TONEMAC Q1
Test Model No.:	TONEMAC Q1
Trade Mark:	TONEMAC
Software Version:	V1.0
Hardware Version:	V1.0
Operation Frequency:	2402MHz~2480MHz
Bluetooth Version:	V5.2
Modulation Technique:	Frequency Hopping Spread Spectrum(FHSS)
Modulation Type:	GFSK, $\pi/4$ DQPSK, 8DPSK
Transfer Rate:	1Mbps/2Mbps/3Mbps
Number of Channel:	79
Hopping Channel Type:	Adaptive Frequency Hopping systems
Product Type:	☐ Mobile ☒ Portable ☐ Fix Location
Test Software of EUT:	Non signaling Test Tool
Antenna Type:	FPC antenna
Antenna Gain:	1dBi
Power Supply:	Charge box:Li-ion battery DC 3.7V 400mAh, Charge by DC 5V for adapter Earphone:Li-ion battery DC 3.7V 70mAh, Charge by DC 5V for Charge box

Operation Frequency each of channel							
Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
0	2402MHz	20	2422MHz	40	2442MHz	60	2462MHz
1	2403MHz	21	2423MHz	41	2443MHz	61	2463MHz
2	2404MHz	22	2424MHz	42	2444MHz	62	2464MHz
3	2405MHz	23	2425MHz	43	2445MHz	63	2465MHz
4	2406MHz	24	2426MHz	44	2446MHz	64	2466MHz
5	2407MHz	25	2427MHz	45	2447MHz	65	2467MHz
6	2408MHz	26	2428MHz	46	2448MHz	66	2468MHz
7	2409MHz	27	2429MHz	47	2449MHz	67	2469MHz
8	2410MHz	28	2430MHz	48	2450MHz	68	2470MHz
9	2411MHz	29	2431MHz	49	2451MHz	69	2471MHz
10	2412MHz	30	2432MHz	50	2452MHz	70	2472MHz
11	2413MHz	31	2433MHz	51	2453MHz	71	2473MHz
12	2414MHz	32	2434MHz	52	2454MHz	72	2474MHz
13	2415MHz	33	2435MHz	53	2455MHz	73	2475MHz
14	2416MHz	34	2436MHz	54	2456MHz	74	2476MHz
15	2417MHz	35	2437MHz	55	2457MHz	75	2477MHz
16	2418MHz	36	2438MHz	56	2458MHz	76	2478MHz
17	2419MHz	37	2439MHz	57	2459MHz	77	2479MHz
18	2420MHz	38	2440MHz	58	2460MHz	78	2480MHz
19	2421MHz	39	2441MHz	59	2461MHz		

Note:

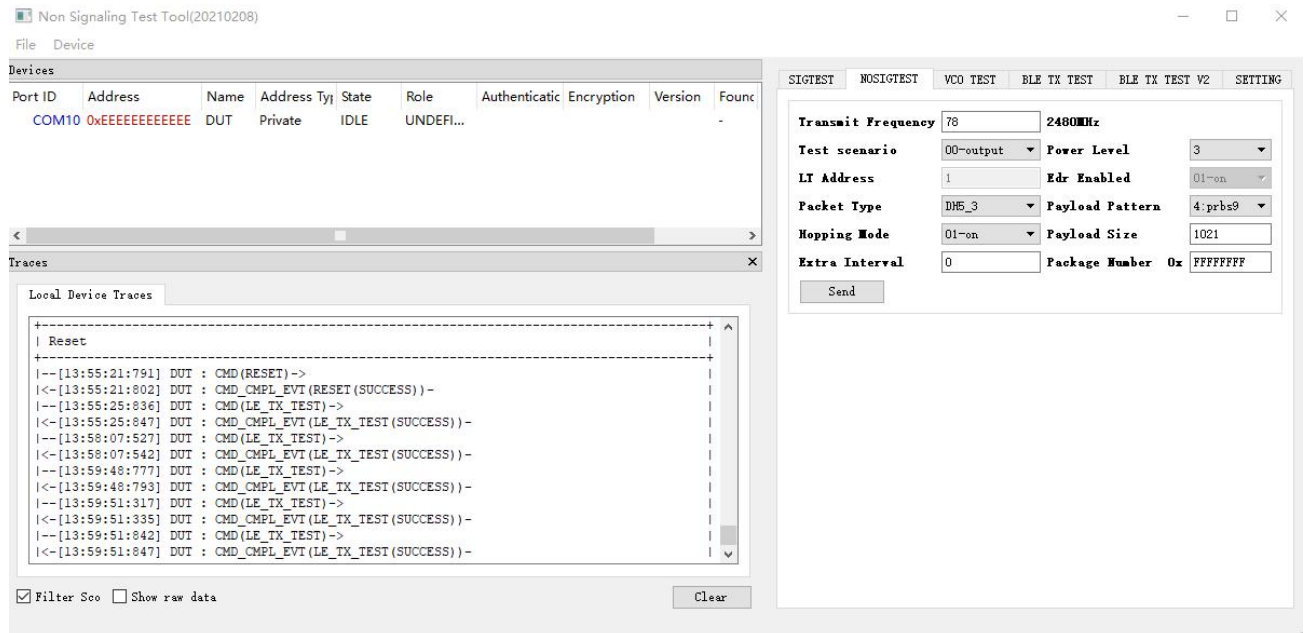
In section 15.31(m), regards to the operating frequency range over 10 MHz, the Lowest frequency, the middle frequency, and the highest frequency of channel were selected to perform the test, and the selected channel see below:

Channel	Frequency
The Lowest channel	2402MHz
The Middle channel	2441MHz
The Highest channel	2480MHz

4.3 Additional Instructions

EUT Test Software Settings:		
Mode:	☒ Special software is used. ☐ Through engineering command into the engineering mode. engineering command: *##3646633##*	
EUT Power level:	Class2 (Power level is built-in set parameters and cannot be changed and selected)	
Use test software to set the lowest frequency, the middle frequency and the highest frequency keep transmitting of the EUT.		
Mode	Channel	Frequency(MHz)
DH1/DH3/DH5	CH0	2402
	CH39	2441
	CH78	2480
2DH1/2DH3/2DH5	CH0	2402
	CH39	2441
	CH78	2480
3DH1/3DH3/3DH5	CH0	2402
	CH39	2441
	CH78	2480

Run Software:



The screenshot shows the 'Non Signaling Test Tool(20210208)' interface. It includes a 'Devices' table with columns for Port ID, Address, Name, Address Type, State, Role, Authentication, Encryption, Version, and Found. A single device 'COM10' is listed with address '0xEEEEEEEEEE', name 'DUT', address type 'Private', state 'IDLE', and role 'UNDEFI...'. Below the devices table is a 'Traces' section with a 'Local Device Traces' window showing a log of commands and responses, including 'Reset', 'CMD(RESET)', and several 'CMD_CMPL_EVT(LE_TX_TEST(SUCCESS))' events. To the right of the traces is a 'Settings' panel with tabs for 'SIGTEST', 'NOSIGTEST', 'VCO TEST', 'BLE TX TEST', 'BLE TX TEST V2', and 'SETTING'. The 'SETTING' tab is active, showing fields for 'Transmit Frequency' (78), 'Power Level' (3), 'LT Address' (1), 'Edr Enabled' (01-on), 'Packet Type' (DHE_3), 'Payload Pattern' (4:prbs9), 'Hopping Mode' (01-on), 'Payload Size' (1021), 'Extra Interval' (0), and 'Package Number' (0x FFFFFFFF). A 'Send' button is located at the bottom of the settings panel.

4.4 Test Environment

Operating Environment:	
Temperature:	25 °C
Humidity:	54% RH
Atmospheric Pressure:	1009mbar
Test Mode:	Use test software to set the lowest frequency, the middle frequency and the highest frequency keep transmitting of the EUT.

4.5 Description of Support Units

The EUT has been tested with associated equipment below.

Description	Manufacturer	Model No.	Remark	Supplied
Adapter	MI	/	/	CQA

4.6 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate.

The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities.

The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16 - 4 „Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC Measurements“ and is documented in the **Shenzhen Huaxia Testing Technology Co., Ltd.** quality system acc. to DIN EN ISO/IEC 17025.

Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Hereafter the best measurement capability for CQA laboratory is reported:

No.	Item	Uncertainty
1	Radiated Emission (Below 1GHz)	5.12dB
2	Radiated Emission (Above 1GHz)	4.60dB
3	Conducted Disturbance (0.15~30MHz)	3.34dB
4	Radio Frequency	3×10^{-8}
5	Duty cycle	0.6 %
6	Occupied Bandwidth	1.1%
7	RF conducted power	0.86dB
8	RF power density	0.74
9	Conducted Spurious emissions	0.86dB
10	Temperature test	0.8℃
11	Humidity test	2.0%
12	Supply voltages	0.5 %
13	Frequency Error	5.5 Hz

4.7 Test Location

All tests were performed at:

Shenzhen Huaxia Testing Technology Co., Ltd.

1F., Block A of Tongsheng Technology Building, Huahui Road, Dalang Street, Longhua District, Shenzhen, China

4.8 Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

IC Registration No.: 22984-1

The 3m Semi-anechoic chamber of Shenzhen Huaxia Testing Technology Co., Ltd. has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing

The test facility is recognized, certified, or accredited by the following organizations:

• **CNAS (No. CNAS L5785)**

CNAS has accredited Shenzhen Huaxia Testing Technology Co., Ltd. Shenzhen Branch EMC Lab to ISO/IEC 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories (CNAS-CL01 Accreditation Criteria for the Competence of Testing and Calibration Laboratories) for the competence in the field of testing.

• **A2LA (Certificate No. 4742.01)**

Shenzhen Huaxia Testing Technology Co., Ltd., Shenzhen EMC Laboratory is accredited by the American Association for Laboratory Accreditation(A2LA). Certificate No. 4742.01.

• **FCC Registration No.: 522263**

Shenzhen Huaxia Testing Technology Co., Ltd., Shenzhen EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Registration No.:522263

4.9 Abnormalities from Standard Conditions

None.

4.10 Other Information Requested by the Customer

None.

4.11 Equipment List

Test Equipment	Manufacturer	Model No.	Instrument No.	Calibration Date	Calibration Due Date
EMI Test Receiver	R&S	ESR7	CQA-005	2022/09/09	2023/09/08
Spectrum analyzer	R&S	FSU26	CQA-038	2022/09/09	2023/09/08
Spectrum analyzer	R&S	FSU40	CQA-075	2022/09/09	2023/09/08
Preamplifier	MITEQ	AFS4-00010300-18-10P-4	CQA-035	2022/09/09	2023/09/08
Preamplifier	MITEQ	AMF-6D-02001800-29-20P	CQA-036	2022/09/09	2023/09/08
Preamplifier	EMCI	EMC184055SE	CQA-089	2022/09/09	2023/09/08
Loop antenna	Schwarzbeck	FMZB1516	CQA-060	2021/09/16	2024/09/15
Bilog Antenna	R&S	HL562	CQA-011	2021/09/16	2024/09/15
Horn Antenna	R&S	HF906	CQA-012	2021/09/16	2024/09/15
Horn Antenna	Schwarzbeck	BBHA 9170	CQA-088	2021/09/16	2024/09/15
Coaxial Cable (Above 1GHz)	CQA	N/A	C007	2022/09/09	2023/09/08
Coaxial Cable (Below 1GHz)	CQA	N/A	C013	2022/09/09	2023/09/08
RF cable(9KHz~40GHz)	CQA	RF-01	CQA-079	2022/09/09	2023/09/08
Antenna Connector	CQA	RFC-01	CQA-080	2022/09/09	2023/09/08
Power Sensor	KEYSIGHT	U2021XA	CQA-30	2022/09/09	2023/09/08
N1918A Power Analysis Manager Power Panel	Agilent	N1918A	CQA-074	2022/09/09	2023/09/08
Power meter	R&S	NRVD	CQA-029	2022/09/09	2023/09/08
Power divider	MIDWEST	PWD-2533-02-SMA-79	CQA-067	2022/09/09	2023/09/08
EMI Test Receiver	R&S	ESR7	CQA-005	2022/09/09	2023/09/08
LISN	R&S	ENV216	CQA-003	2022/09/09	2023/09/08
Coaxial cable	CQA	N/A	CQA-C009	2022/09/09	2023/09/08
DC power	KEYSIGHT	E3631A	CQA-028	2022/09/09	2023/09/08

Note:

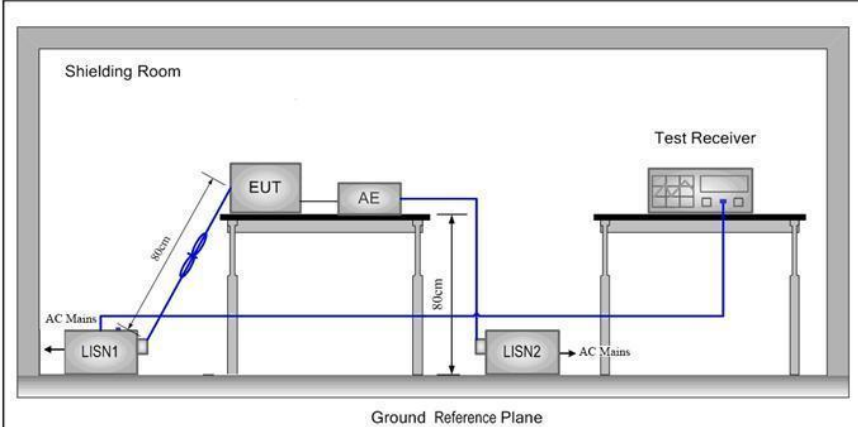
The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.

5 Test results and Measurement Data

5.1 Antenna Requirement

Standard requirement:	47 CFR Part 15C Section 15.203 /247(c)
15.203 requirement: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. 15.247(b) (4) requirement: The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.	
EUT Antenna:	
The antenna is FPC antenna. The best case gain of the antenna is 1 dBi.	

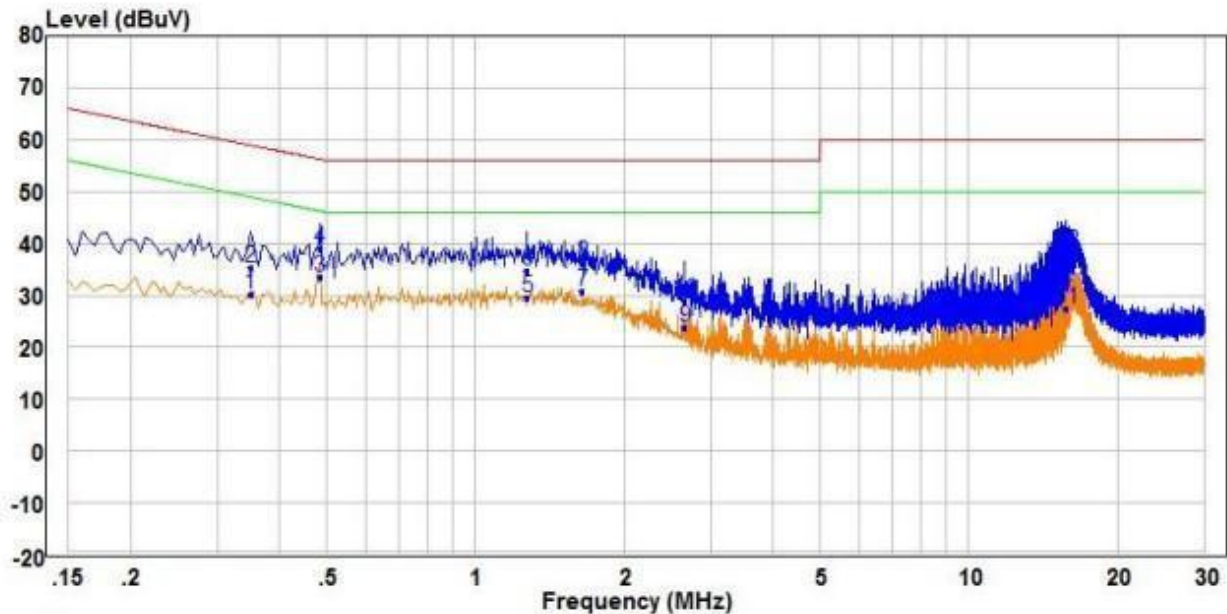
5.2 Conducted Emissions

Test Requirement:	47 CFR Part 15C Section 15.207		
Test Method:	ANSI C63.10: 2013		
Test Frequency Range:	150kHz to 30MHz		
Limit:	Frequency range (MHz)	Limit (dBuV)	
		Quasi-peak	Average
	0.15-0.5	66 to 56*	56 to 46*
	0.5-5	56	46
	5-30	60	50
* Decreases with the logarithm of the frequency.			
Test Procedure:	1) The mains terminal disturbance voltage test was conducted in a shielded room. 2) The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a $50\Omega/50\mu\text{H} + 5\Omega$ linear impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded. 3) The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane, 4) The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0.4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal ground reference plane. The LISN 1 was placed 0.8 m from the boundary of the unit under test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane. This distance was between the closest points of the LISN 1 and the EUT. All other units of the EUT and associated equipment was at least 0.8 m from the LISN 2. 5) In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10: 2013 on conducted measurement.		
Test Setup:			

Final Test Mode:	Charging mode
Test Voltage:	AC 120V/60Hz
Test Results:	Pass

Measurement Data

Live line:

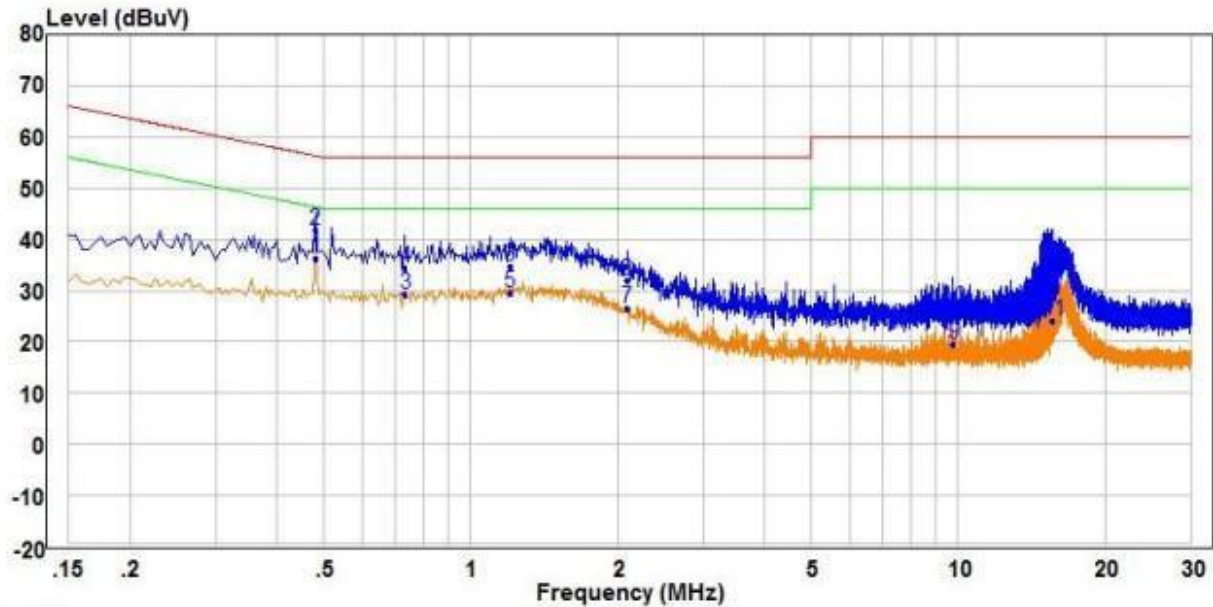


	Freq	Read	Factor	Level	Limit	Over	Remark	Pol/Phase
	MHz	dBuV	dB	dBuV	dBuV	dB		
1	0.350	20.57	9.50	30.07	48.96	-18.89	Average	Line
2	0.350	25.81	9.50	35.31	58.96	-23.65	QP	Line
3 PP	0.485	24.02	9.52	33.54	46.25	-12.71	Average	Line
4 QP	0.485	29.33	9.52	38.85	56.25	-17.40	QP	Line
5	1.275	19.98	9.52	29.50	46.00	-16.50	Average	Line
6	1.275	25.35	9.52	34.87	56.00	-21.13	QP	Line
7	1.650	21.25	9.52	30.77	46.00	-15.23	Average	Line
8	1.650	26.62	9.52	36.14	56.00	-19.86	QP	Line
9	2.660	14.33	9.58	23.91	46.00	-22.09	Average	Line
10	2.660	19.39	9.58	28.97	56.00	-27.03	QP	Line
11	15.755	17.46	9.93	27.39	50.00	-22.61	Average	Line
12	15.755	28.38	9.93	38.31	60.00	-21.69	QP	Line

Remark:

1. The following Quasi-Peak and Average measurements were performed on the EUT:
2. Final Test Level = Receiver Reading + LISN Factor + Cable Loss.
3. If the Peak value under Average limit, the Average value is not recorded in the report.

Neutral line:

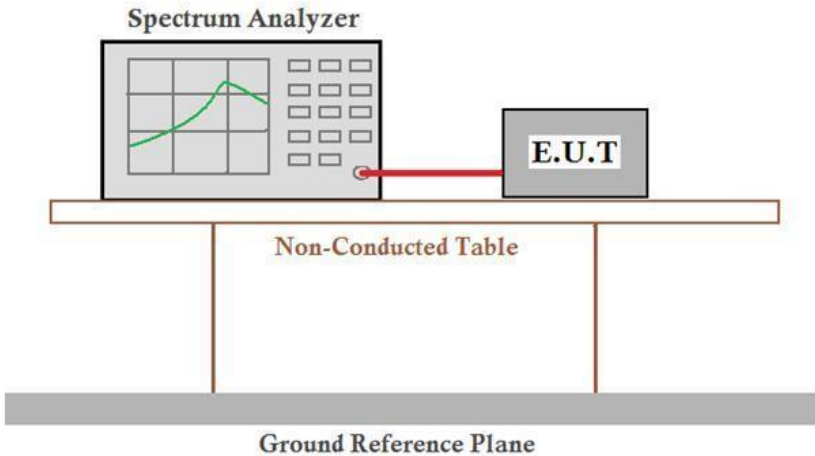


		Read			Limit	Over			
	Freq	Level	Factor	Level	Line	Limit	Remark	Pol/Phase	
	MHz	dBuV	dB	dBuV	dBuV	dB			
1	PP	0.480	26.42	9.68	36.10	46.34	-10.24	Average	Neutral
2	QP	0.480	31.94	9.68	41.62	56.34	-14.72	QP	Neutral
3		0.735	19.39	9.88	29.27	46.00	-16.73	Average	Neutral
4		0.735	24.42	9.88	34.30	56.00	-21.70	QP	Neutral
5		1.205	19.70	9.71	29.41	46.00	-16.59	Average	Neutral
6		1.205	24.99	9.71	34.70	56.00	-21.30	QP	Neutral
7		2.095	16.79	9.75	26.54	46.00	-19.46	Average	Neutral
8		2.095	22.15	9.75	31.90	56.00	-24.10	QP	Neutral
9		9.780	9.56	9.89	19.45	50.00	-30.55	Average	Neutral
10		9.780	16.69	9.89	26.58	60.00	-33.42	QP	Neutral
11		15.635	14.45	9.74	24.19	50.00	-25.81	Average	Neutral
12		15.635	25.40	9.74	35.14	60.00	-24.86	QP	Neutral

Remark:

1. The following Quasi-Peak and Average measurements were performed on the EUT:
2. Final Test Level =Receiver Reading + LISN Factor + Cable Loss.
3. If the Peak value under Average limit, the Average value is not recorded in the report.

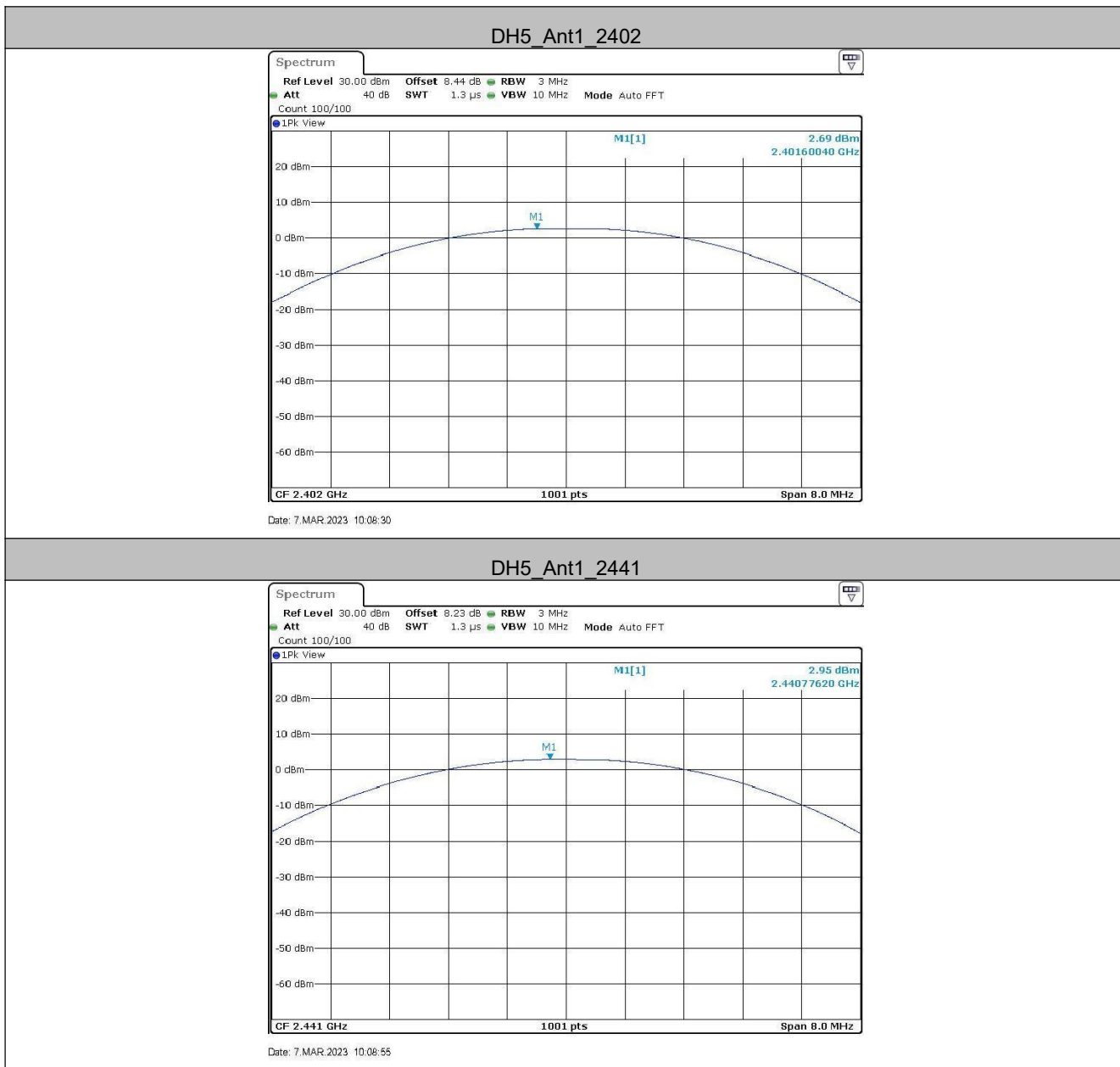
5.3 Conducted Peak Output Power

Test Requirement:	47 CFR Part 15C Section 15.247 (b)(1)
Test Method:	ANSI C63.10:2013
Test Setup:	 Remark: Offset=Cable loss+ attenuation factor.
Limit:	21dBm
Exploratory Test Mode:	Non-hopping transmitting with all kind of modulation and all kind of data type
Final Test Mode:	Through Pre-scan, find the DH5 of data type is the worst case of GFSK modulation type, 2-DH5 of data type is the worst case of $\pi/4$ DQPSK modulation type, 3-DH5 of data type is the worst case of 8DPSK modulation type. Only the worst case is recorded in the report.
Test Results:	Pass

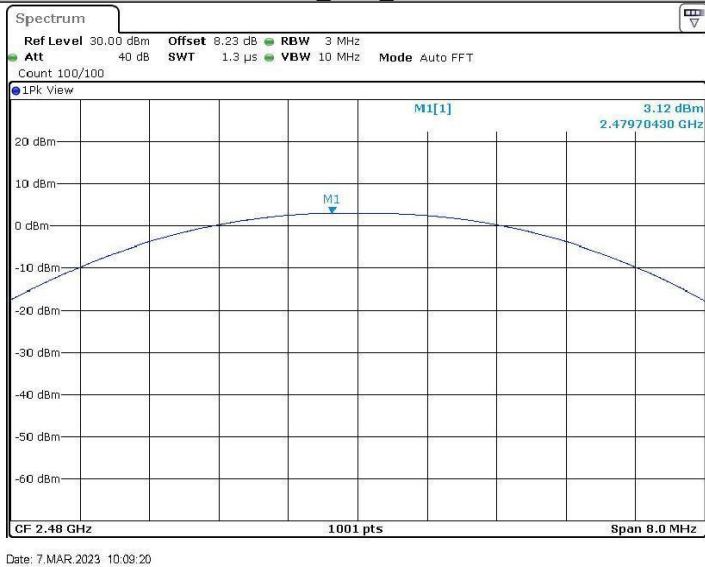
Measurement Data

GFSK mode			
Test channel	Peak Output Power (dBm)	Limit (dBm)	Result
Lowest	2.69	21.00	Pass
Middle	2.95	21.00	Pass
Highest	3.12	21.00	Pass
$\pi/4$ DQPSK mode			
Test channel	Peak Output Power (dBm)	Limit (dBm)	Result
Lowest	2.44	21.00	Pass
Middle	2.65	21.00	Pass
Highest	2.96	21.00	Pass
8DPSK mode			
Test channel	Peak Output Power (dBm)	Limit (dBm)	Result
Lowest	2.5	21.00	Pass
Middle	2.68	21.00	Pass
Highest	2.68	21.00	Pass

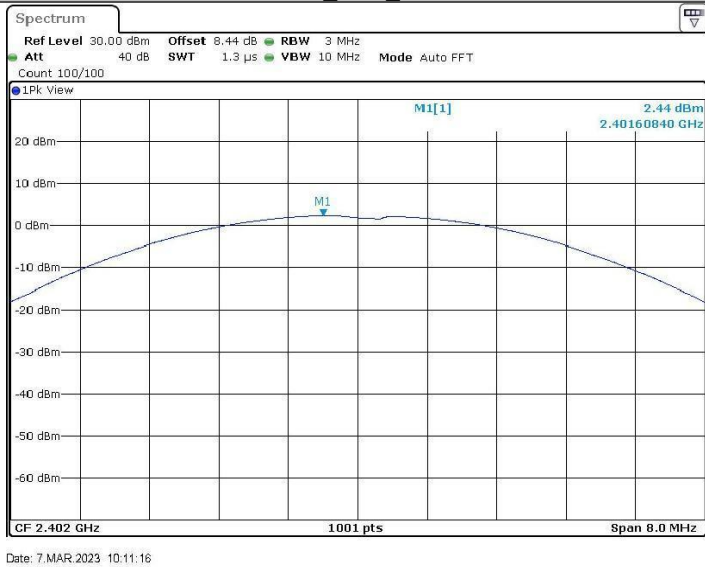
Test plot as follows:



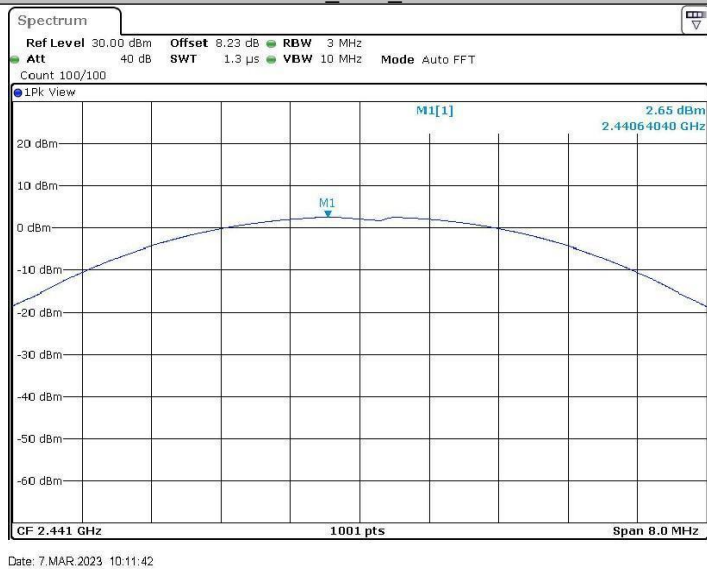
DH5_Ant1_2480



2DH5_Ant1_2402



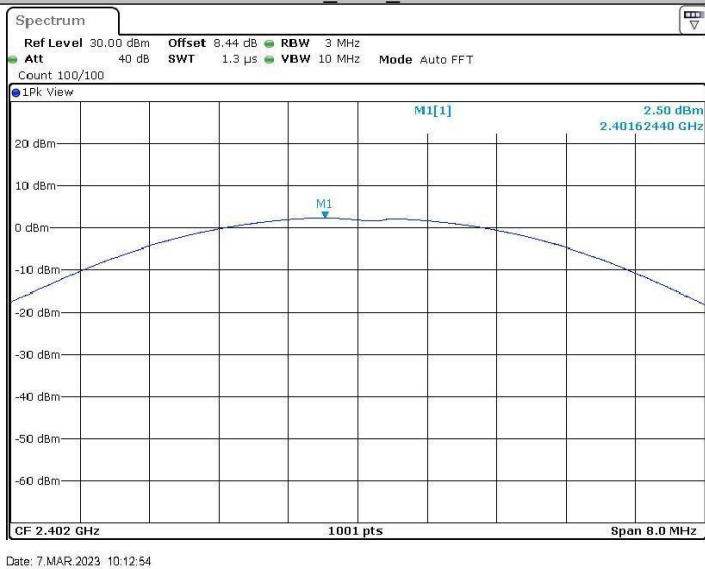
2DH5_Ant1_2441



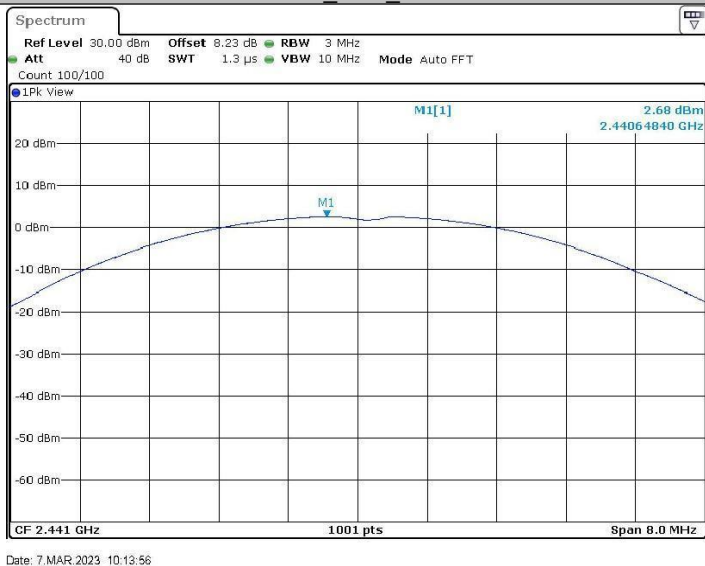
2DH5_Ant1_2480

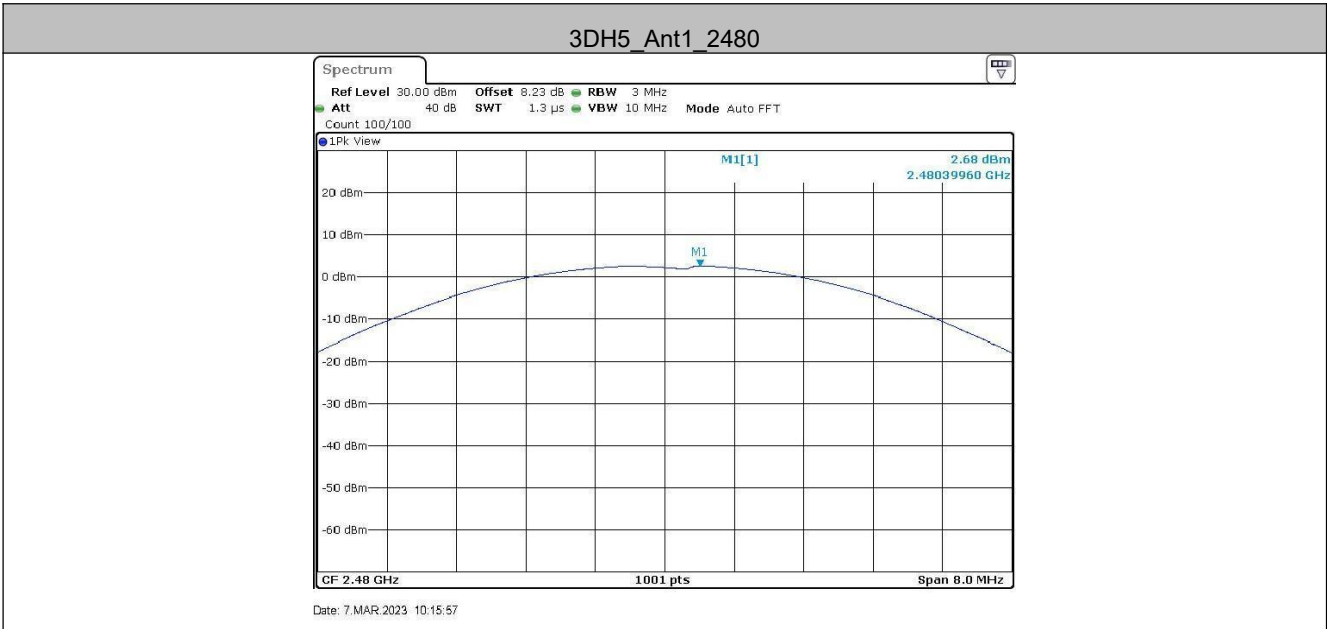


3DH5_Ant1_2402

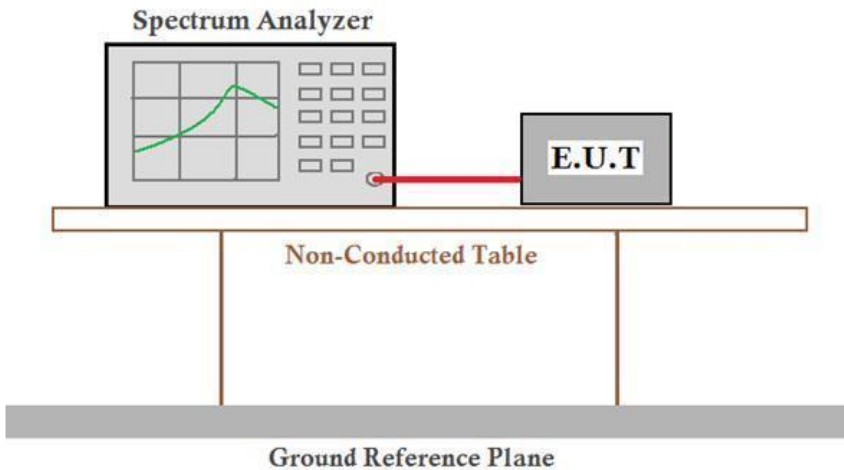


3DH5_Ant1_2441





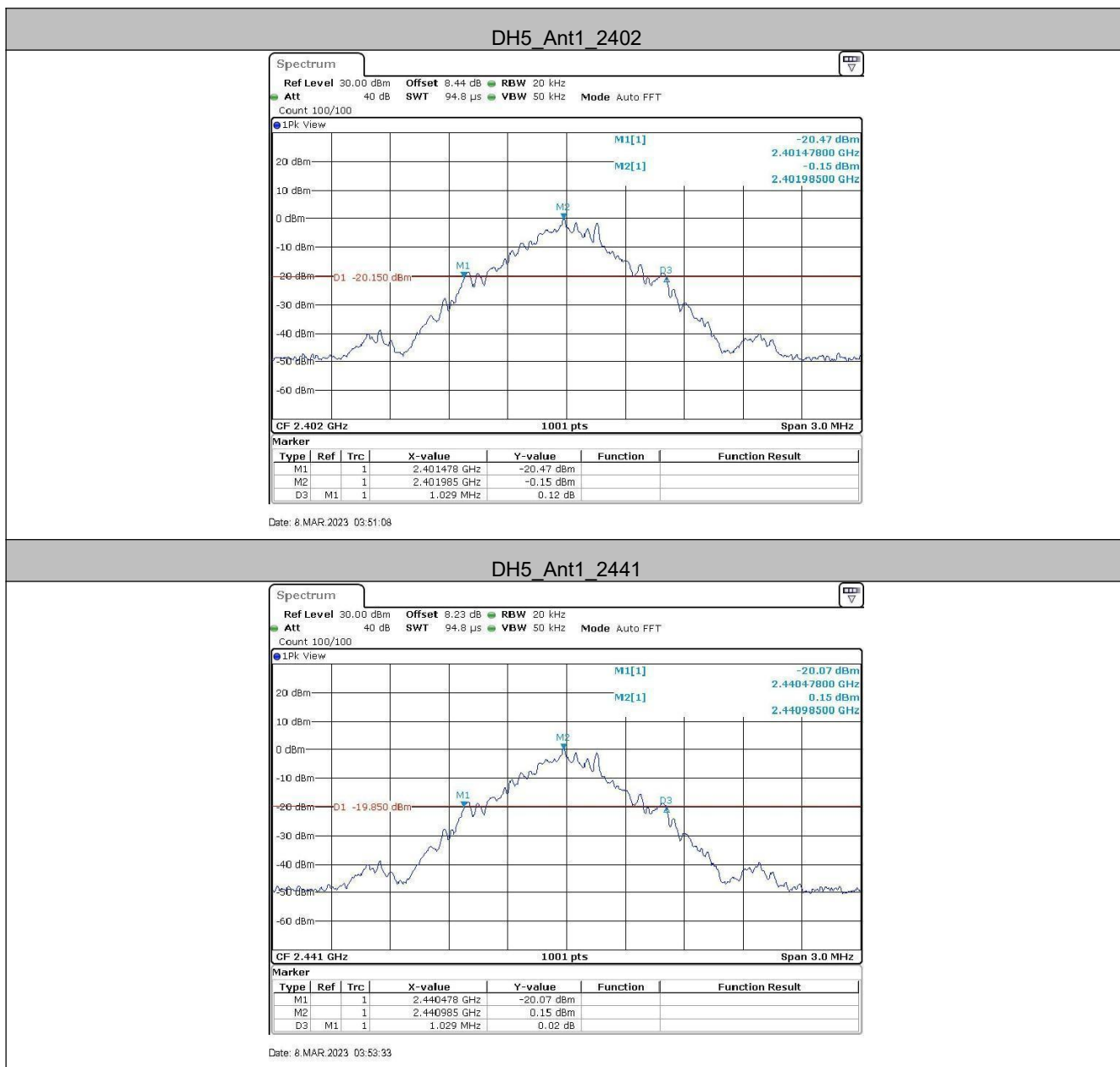
5.4 20dB Occupy Bandwidth

Test Requirement:	47 CFR Part 15C Section 15.247 (a)(1)
Test Method:	ANSI C63.10:2013
Test Setup:	 Remark: Offset=Cable loss+ attenuation factor.
Limit:	NA
Exploratory Test Mode:	Non-hopping transmitting with all kind of modulation and all kind of data type
Final Test Mode:	Through Pre-scan, find the DH5 of data type is the worst case of GFSK modulation type, 2-DH5 of data type is the worst case of $\pi/4$ DQPSK modulation type, 3-DH5 of data type is the worst case of 8DPSK modulation type. Only the worst case is recorded in the report.
Test Results:	Pass

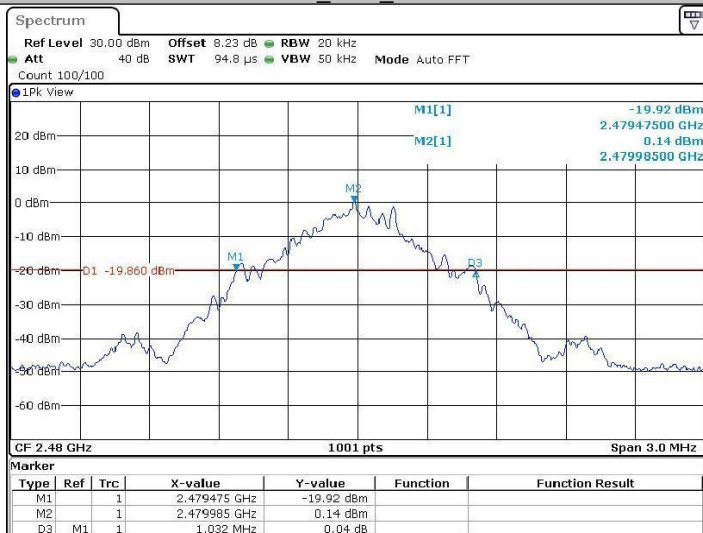
Measurement Data

Test channel	20dB Occupy Bandwidth (MHz)		
	GFSK	$\pi/4$ DQPSK	8DPSK
Lowest	1.03	1.18	1.18
Middle	1.03	1.18	1.23
Highest	1.03	1.18	1.23

Test plot as follows:

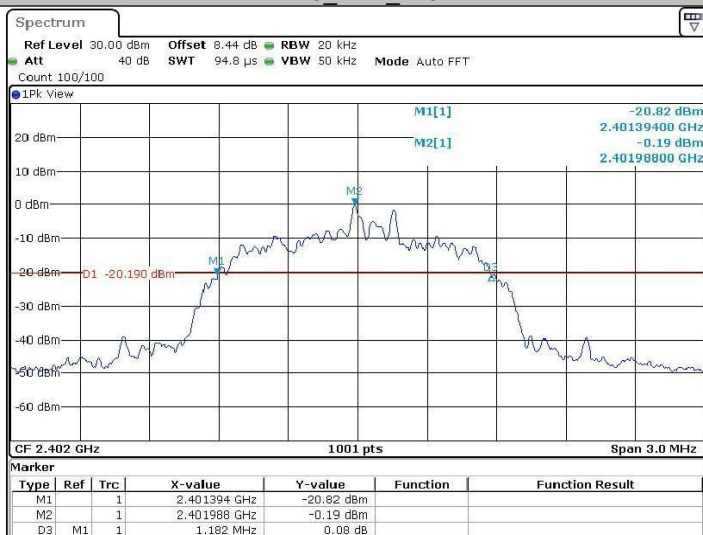


DH5_Ant1_2480



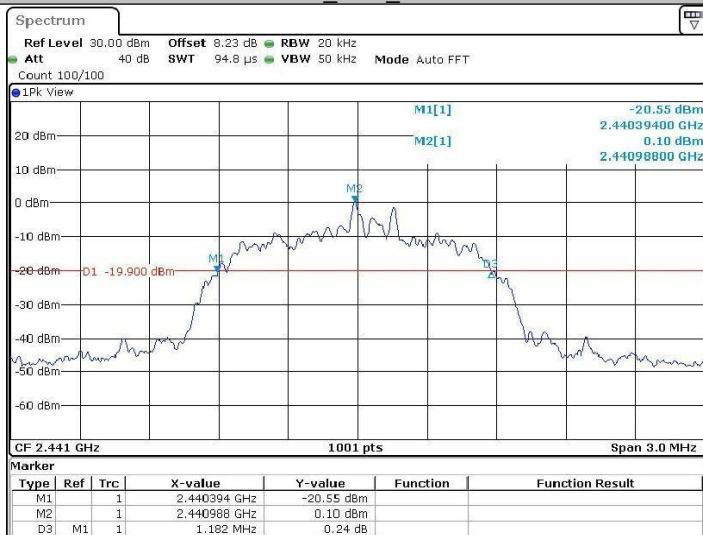
Date: 8 MAR 2023 03:57:44

2DH5_Ant1_2402



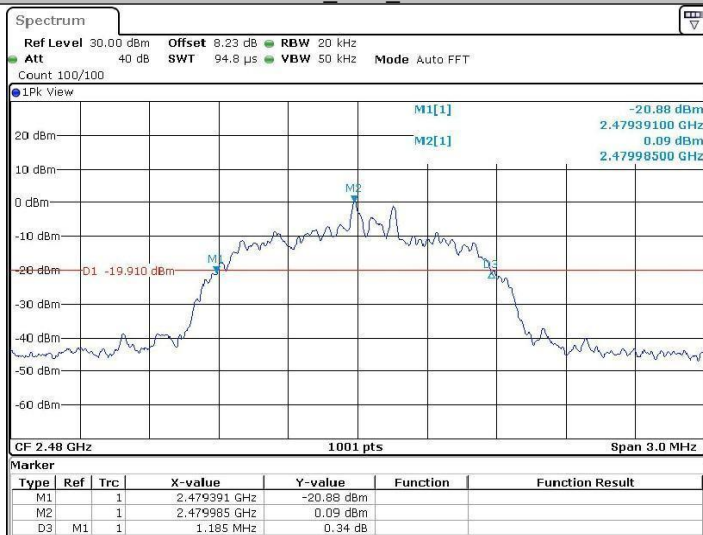
Date: 8 MAR 2023 04:02:12

2DH5_Ant1_2441



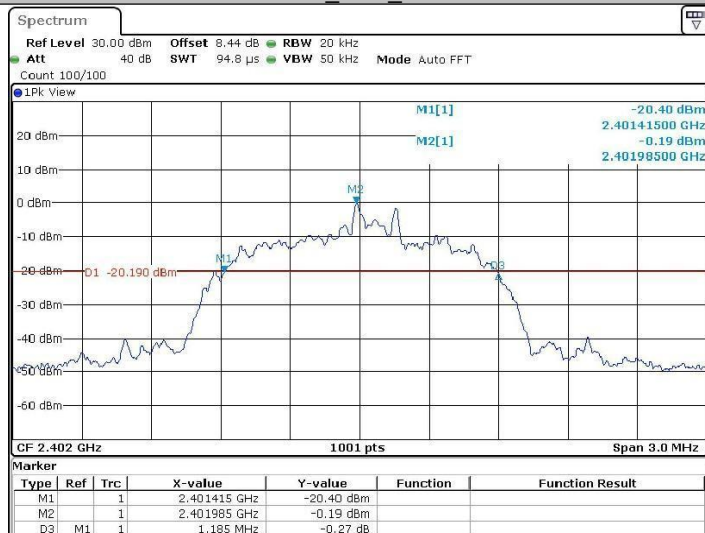
Date: 8 MAR 2023 04:05:45

2DH5_Ant1_2480



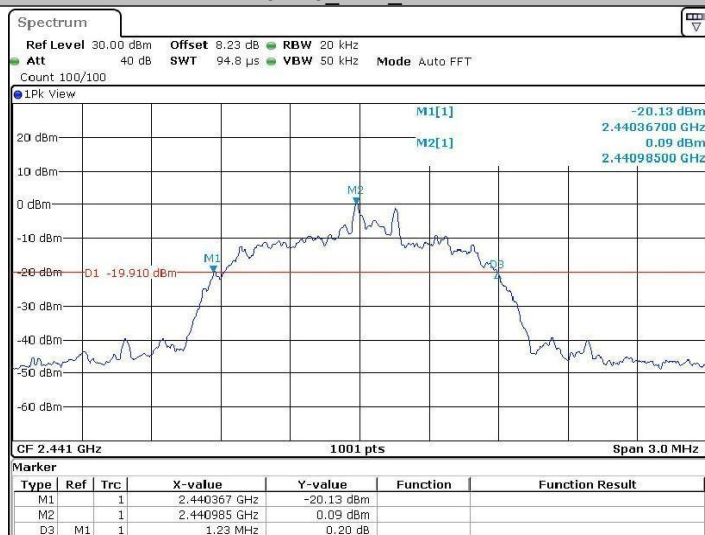
Date: 8 MAR 2023 04:07:00

3DH5_Ant1_2402



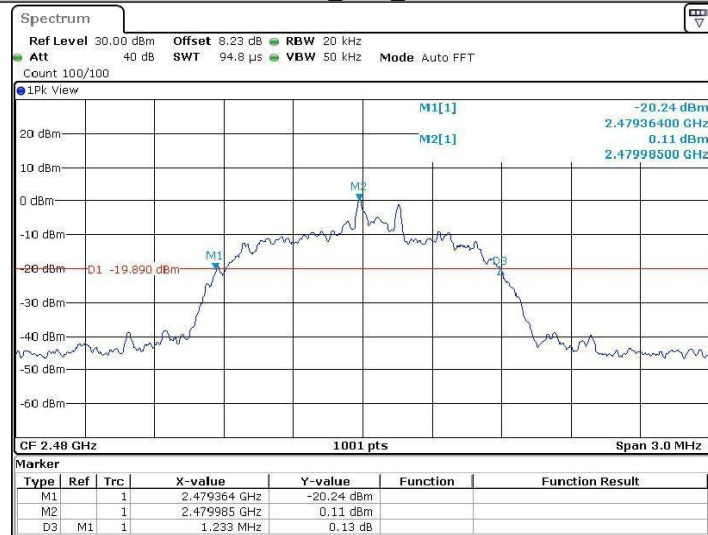
Date: 8 MAR 2023 04:09:28

3DH5_Ant1_2441



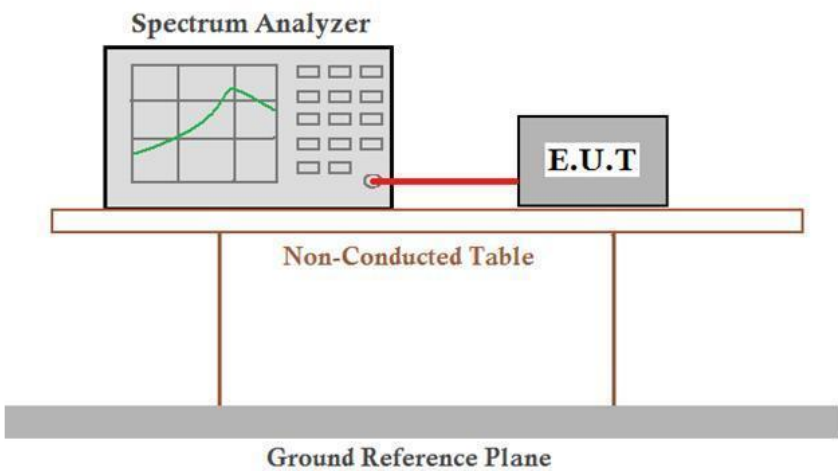
Date: 8 MAR 2023 04:13:25

3DH5_Ant1_2480



Date: 8 MAR 2023 04:15:43

5.5 Carrier Frequencies Separation

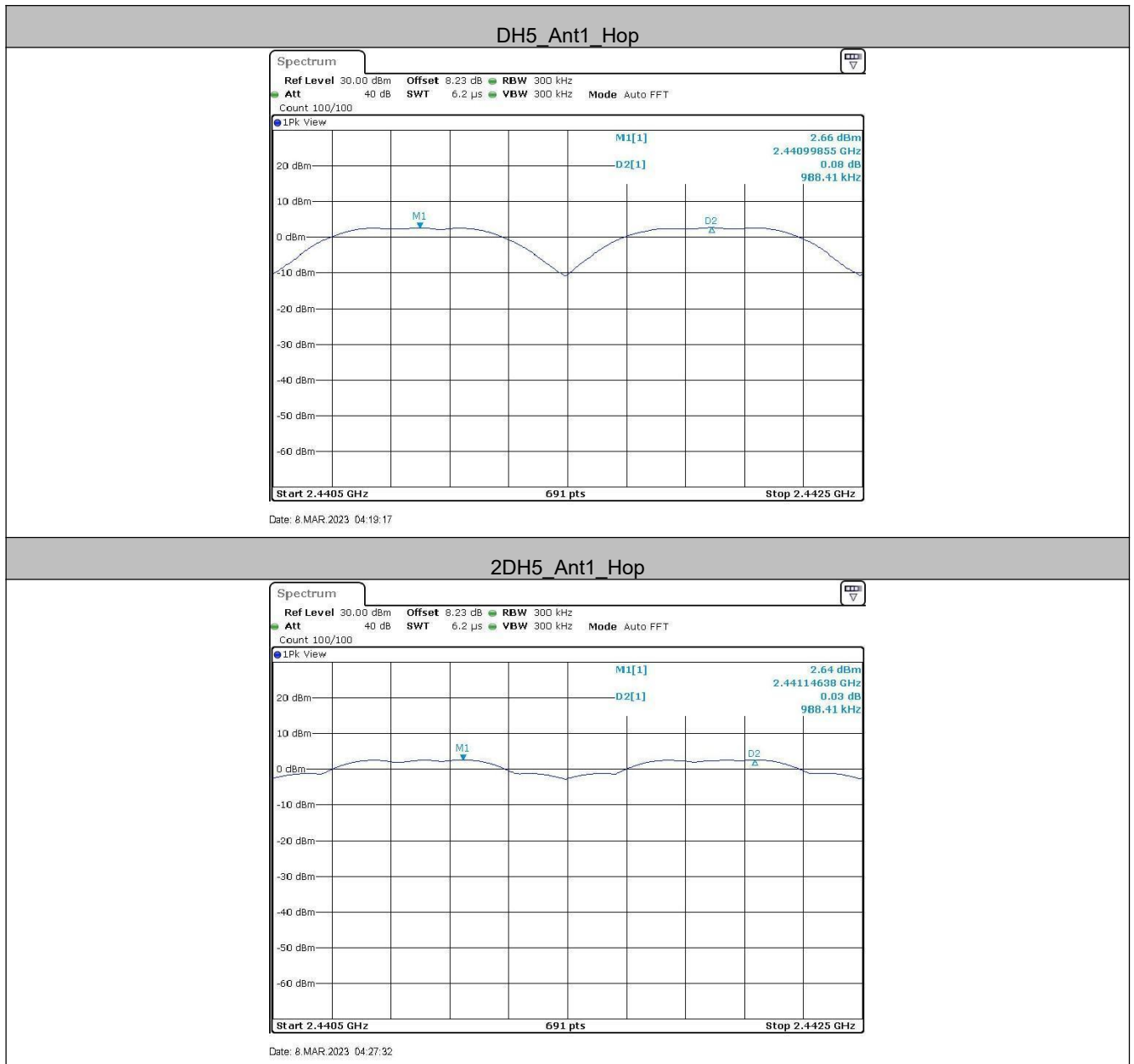
Test Requirement:	47 CFR Part 15C Section 15.247 (a)(1)
Test Method:	ANSI C63.10:2013
Test Setup:	 Remark: Offset=Cable loss+ attenuation factor.
Limit:	2/3 of the 20dB bandwidth
	Remark: the transmission power is less than 0.125W.
Exploratory Test Mode:	Hopping transmitting with all kind of modulation and all kind of data type
Final Test Mode:	Through Pre-scan, find the DH5 of data type is the worst case of GFSK modulation type, 2-DH5 of data type is the worst case of $\pi/4$ DQPSK modulation type, 3-DH5 of data type is the worst case of 8DPSK modulation type. Only the worst case is recorded in the report.
Test Results:	Pass

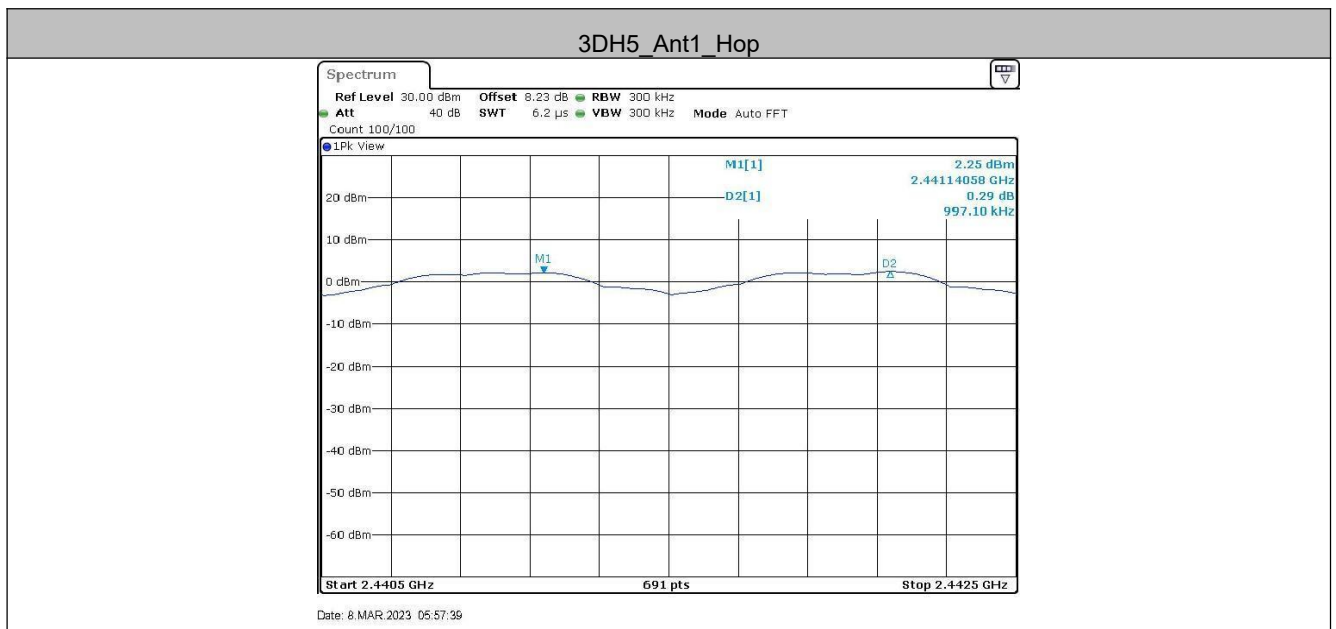
Measurement Data

TestMode	Antenna	Freq(MHz)	Result[MHz]	Limit[MHz]	Verdict
DH5	Ant1	Hop	0.988	≥0.687	PASS
2DH5	Ant1	Hop	0.988	≥0.787	PASS
3DH5	Ant1	Hop	0.997	≥0.820	PASS

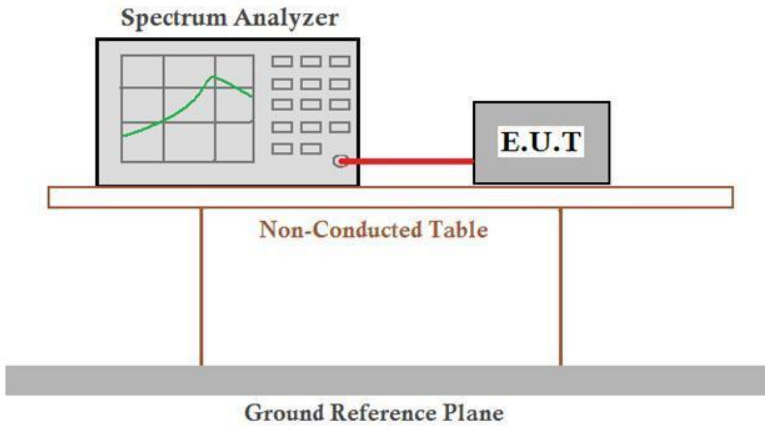
Mode	20dB bandwidth (MHz) (worse case)	Limit (MHz) (Carrier Frequencies Separation)
GFSK	1.03	≥0.687
$\pi/4$ DQPSK	1.18	≥0.787
8DPSK	1.23	≥0.820

Test plot as follows:





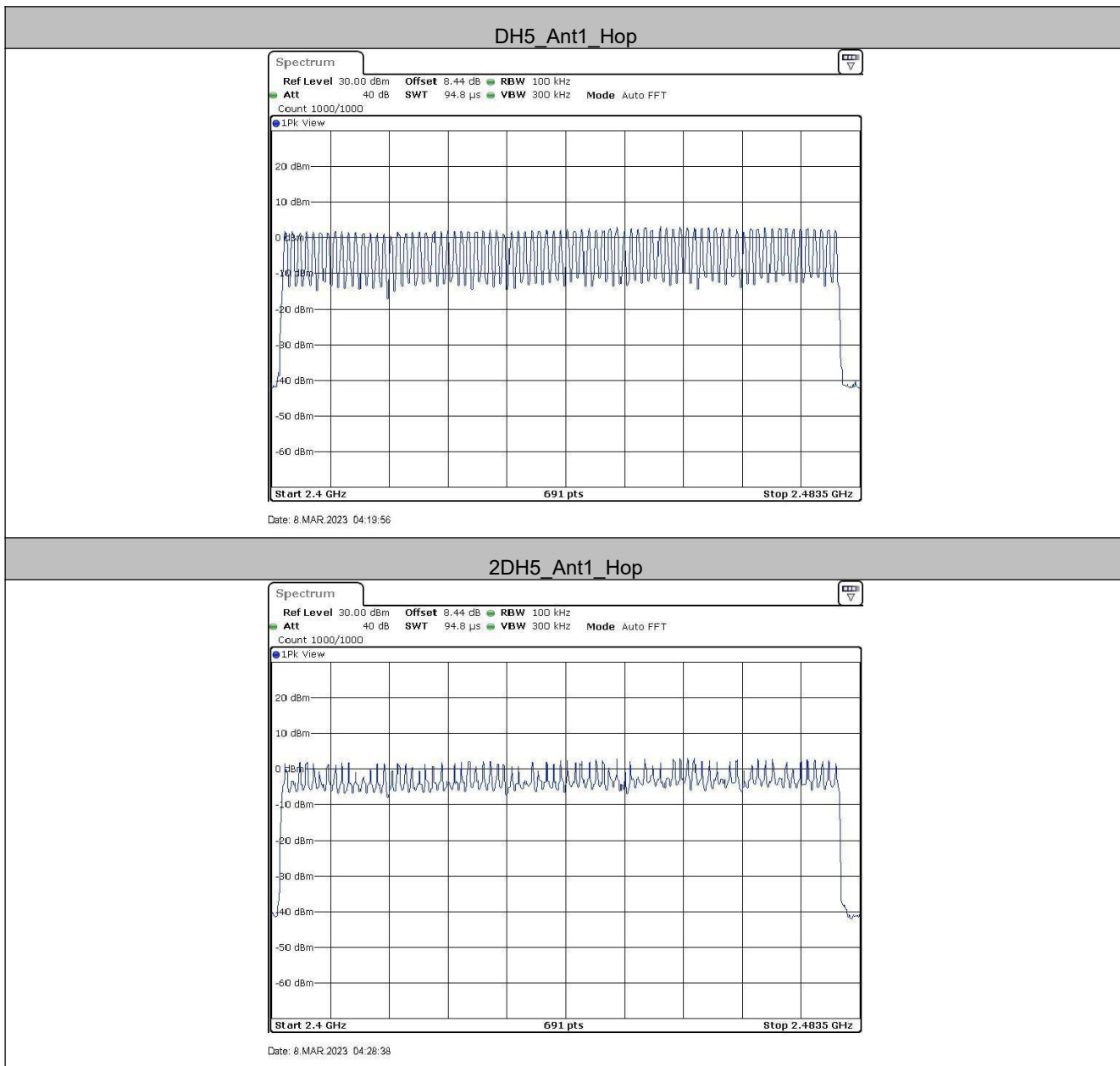
5.6 Hopping Channel Number

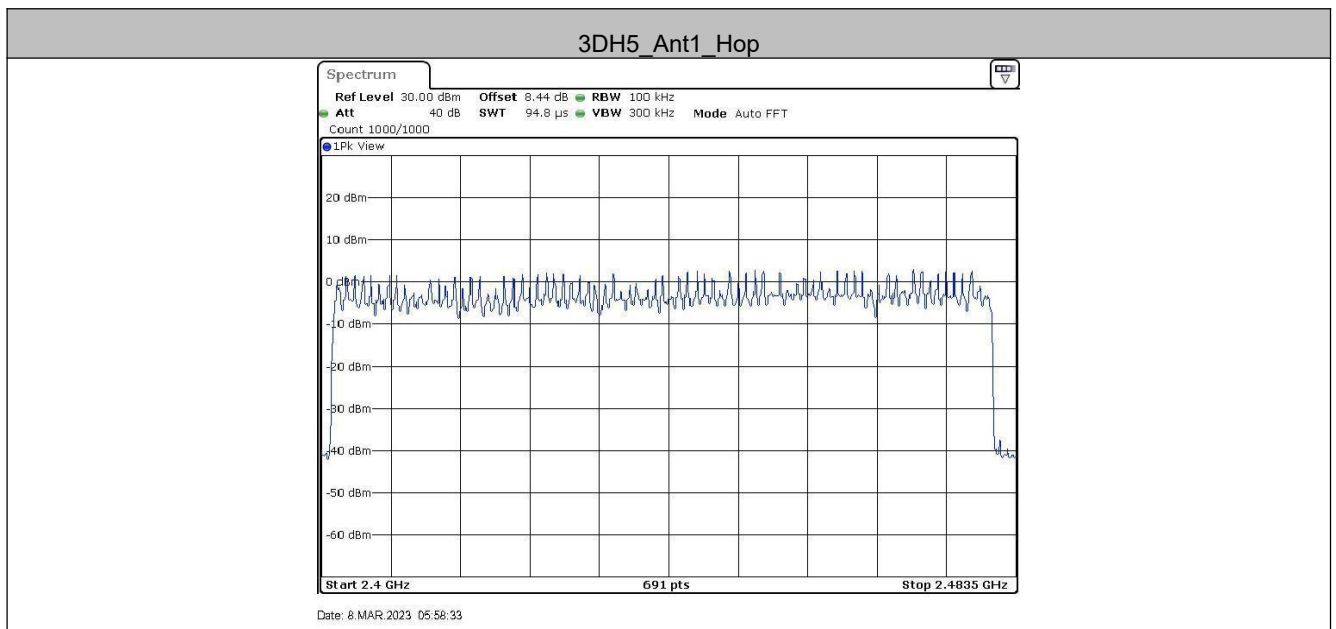
Test Requirement:	47 CFR Part 15C Section 15.247 (a)(1)
Test Method:	ANSI C63.10:2013
Test Setup:	 Remark: Offset=Cable loss+ attenuation factor.
Limit:	At least 15 channels
Exploratory Test Mode:	hopping transmitting with all kind of modulation and all kind of data type
Final Test Mode:	Through Pre-scan, find the DH5 of data type is the worst case of GFSK modulation type, 2-DH5 of data type is the worst case of $\pi/4$ DQPSK modulation type, 3-DH5 of data type is the worst case of 8DPSK modulation type. Only the worst case is recorded in the report.
Test Results:	Pass

Measurement Data

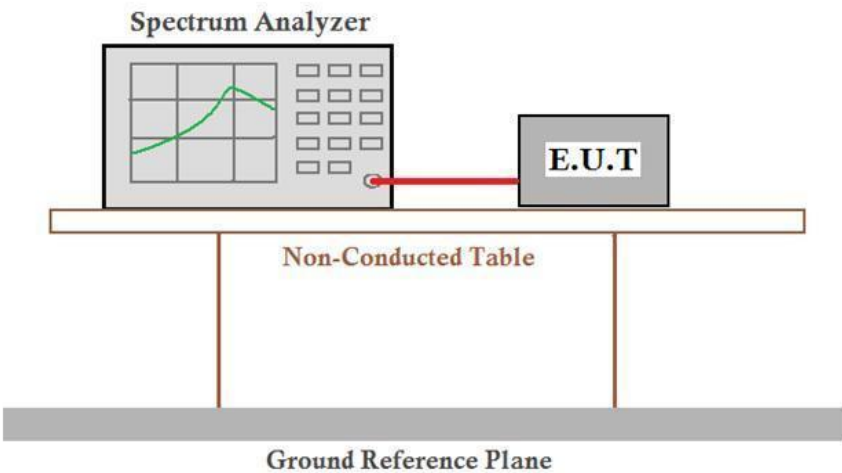
Mode	Hopping channel numbers	Limit
GFSK	79	≥ 15
$\pi/4$ DQPSK	79	≥ 15
8DPSK	79	≥ 15

Test plot as follows:





5.7 Dwell Time

Test Requirement:	47 CFR Part 15C Section 15.247 (a)(1)
Test Method:	ANSI C63.10:2013
Test Setup:	 Remark: Offset=Cable loss+ attenuation factor.
Test Mode:	Hopping transmitting with all kind of modulation and all kind of data type.
Limit:	0.4 Second
Test Results:	Pass

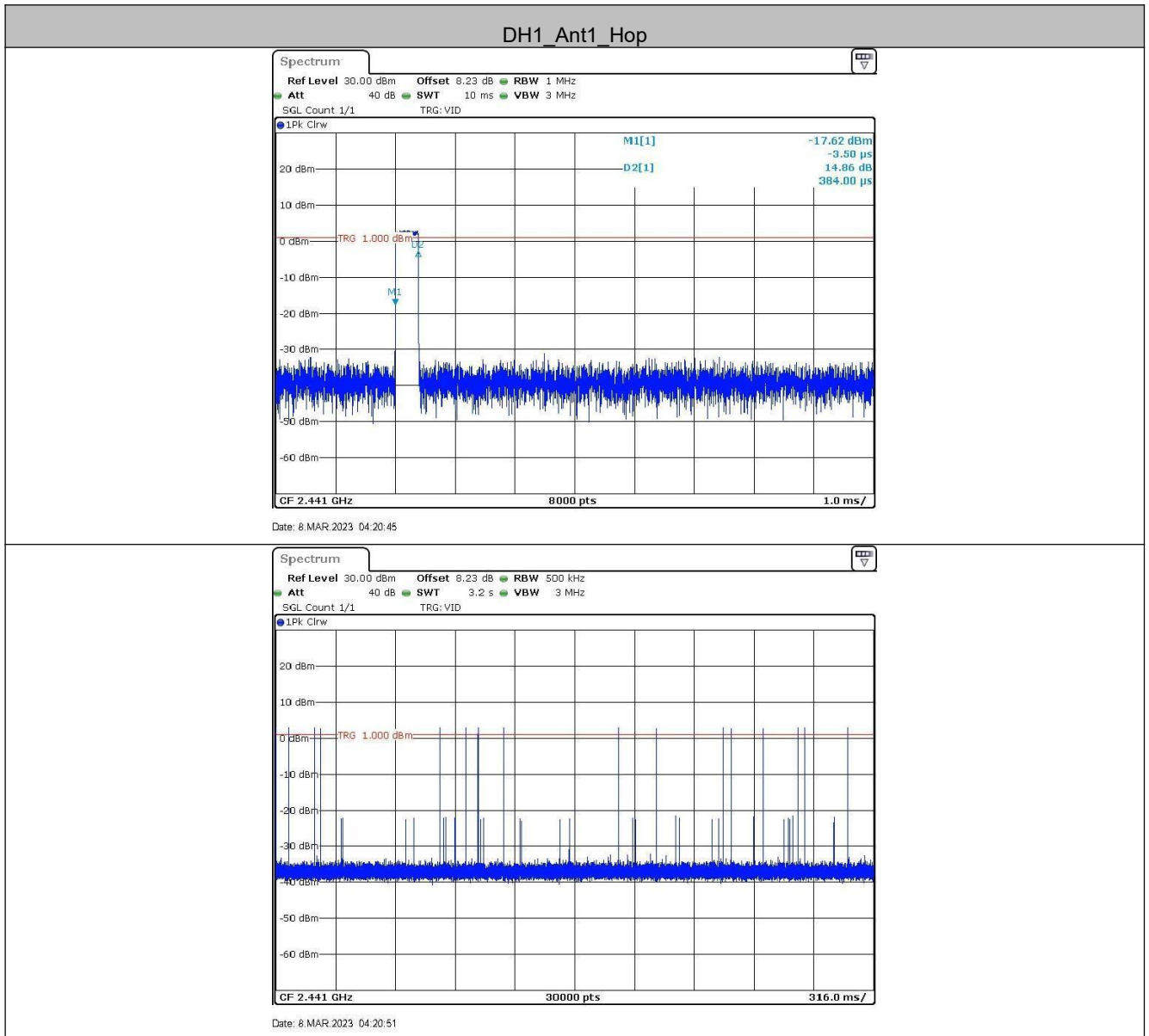
Measurement Data

TestMode	Antenna	Freq(MHz)	BurstWidth [ms]	TotalHops [Num]	Result[s]	Limit[s]	Verdict
DH1	Ant1	Hop	0.384	160	0.061	≤0.4	PASS
DH3	Ant1	Hop	1.633	120	0.196	≤0.4	PASS
DH5	Ant1	Hop	2.873	70	0.201	≤0.4	PASS
2DH1	Ant1	Hop	0.393	140	0.055	≤0.4	PASS
2DH3	Ant1	Hop	1.638	100	0.164	≤0.4	PASS
2DH5	Ant1	Hop	2.878	90	0.259	≤0.4	PASS
3DH1	Ant1	Hop	0.394	180	0.071	≤0.4	PASS
3DH3	Ant1	Hop	1.636	100	0.164	≤0.4	PASS
3DH5	Ant1	Hop	2.879	80	0.23	≤0.4	PASS

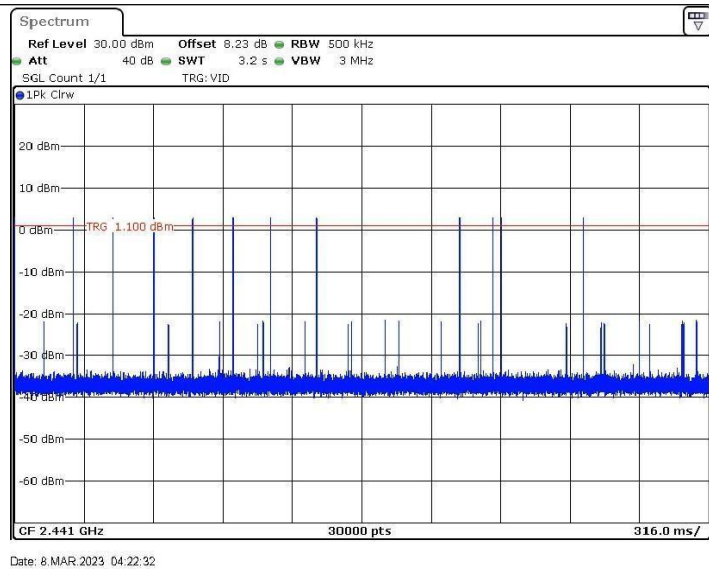
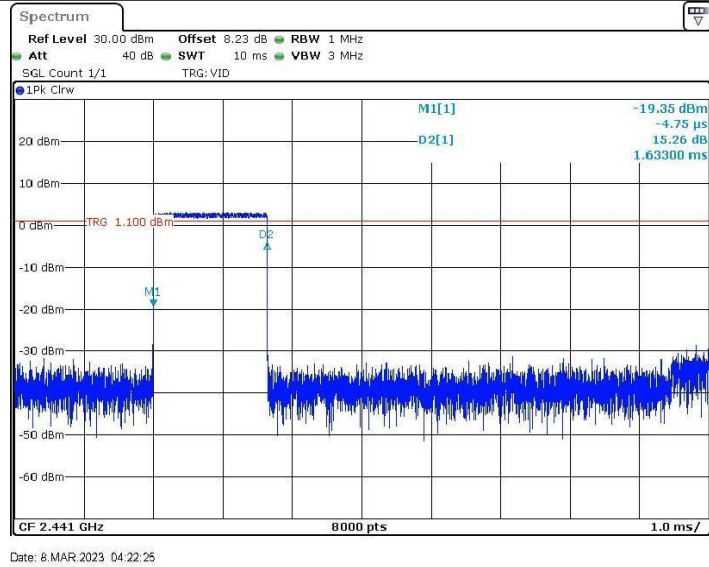
Remark:

The test period: $T = 0.4 \text{ Second/Channel} \times 79 \text{ Channel} = 31.6 \text{ s}$

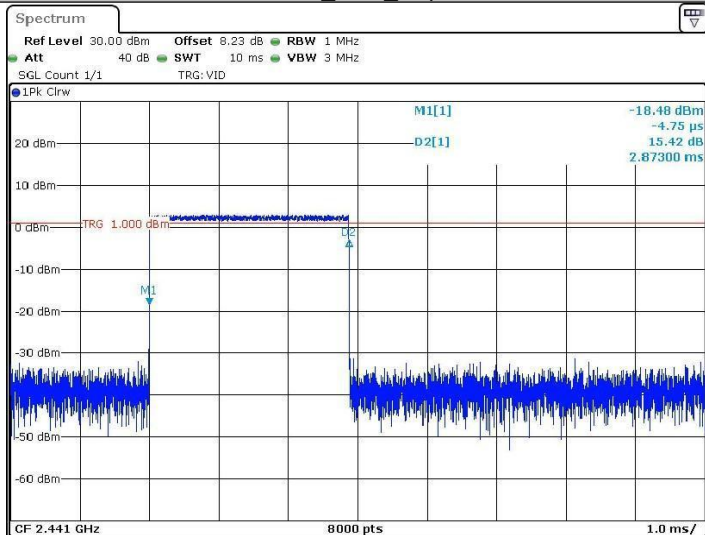
Test plot as follows:



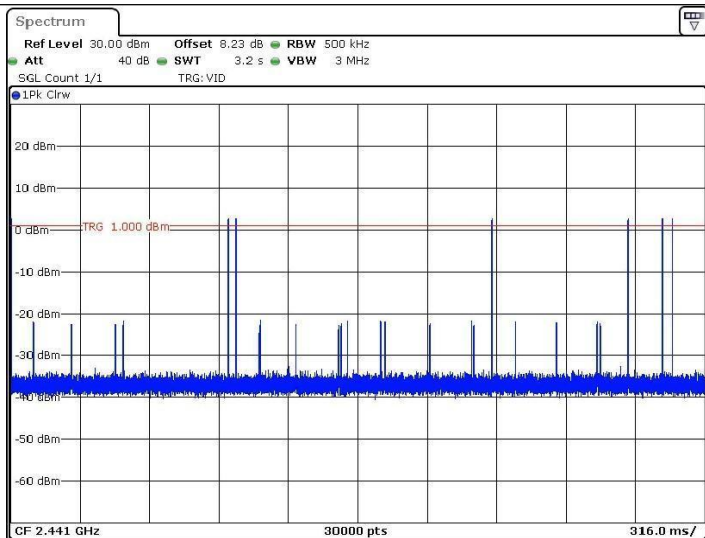
DH3_Ant1_Hop



DH5_Ant1_Hop

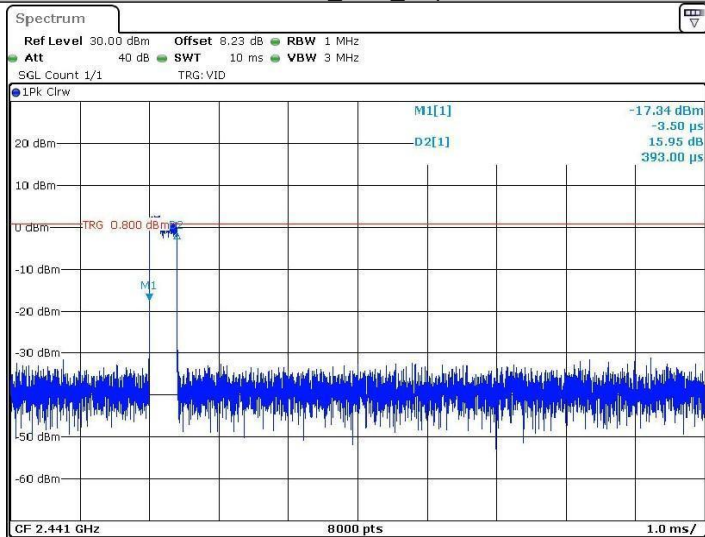


Date: 8 MAR 2023 04:20:12

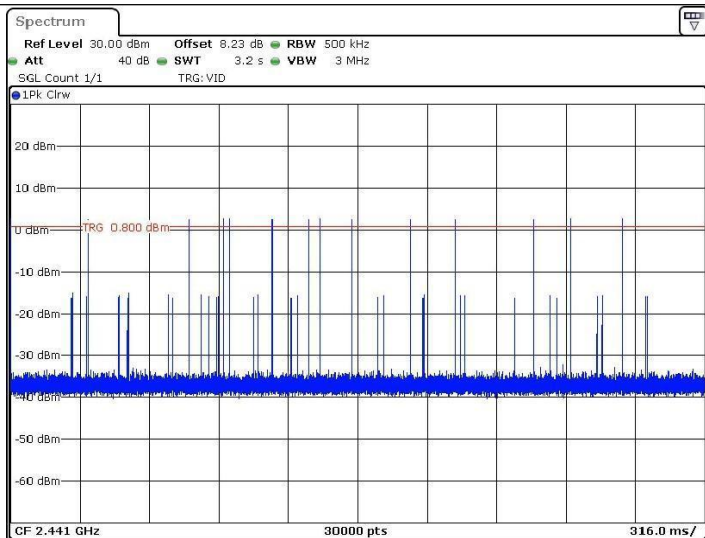


Date: 8 MAR 2023 04:20:18

2DH1_Ant1_Hop

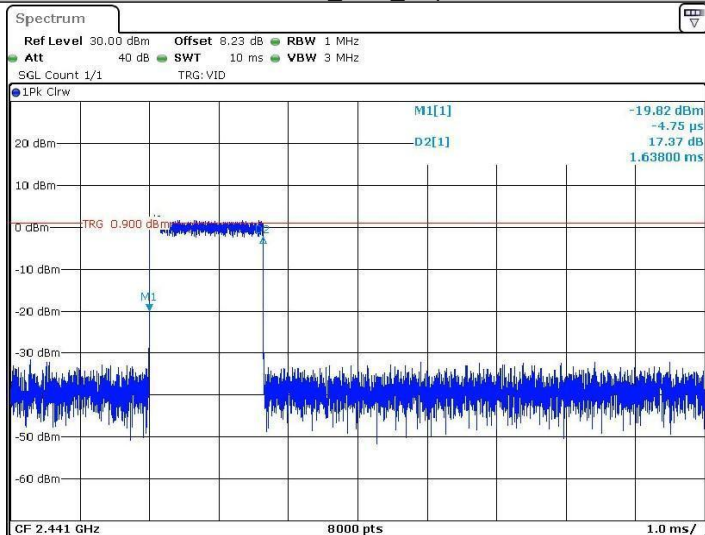


Date: 8 MAR 2023 05:49:40

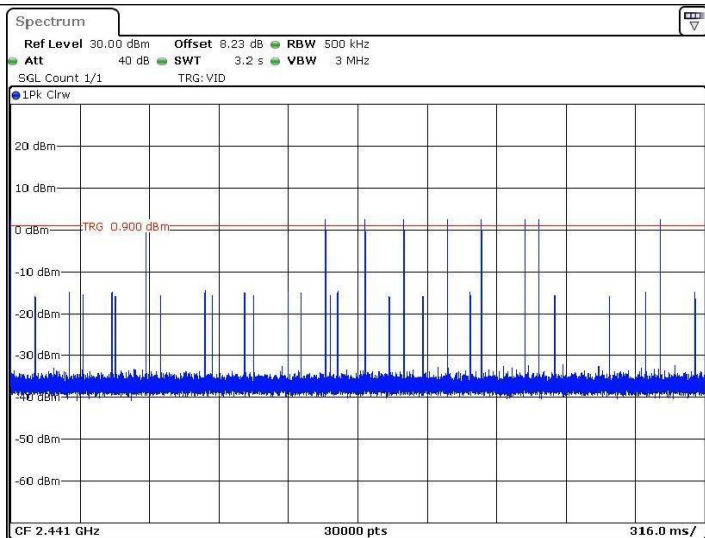


Date: 8 MAR 2023 05:49:46

2DH3_Ant1_Hop

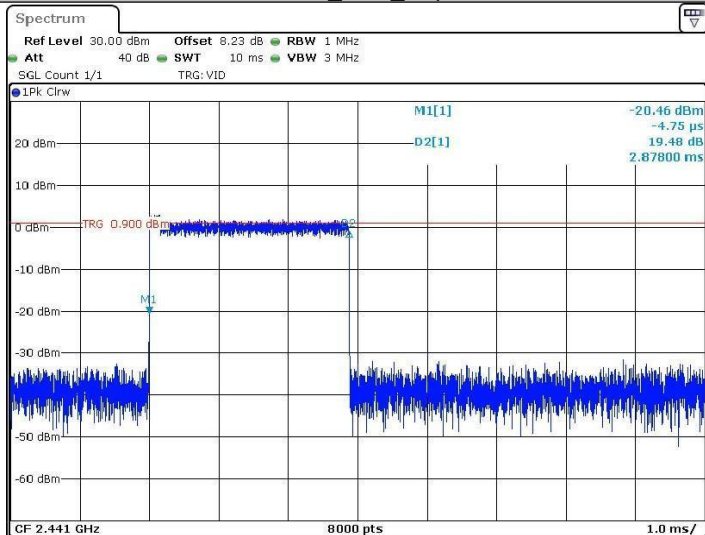


Date: 8 MAR 2023 05:51:19

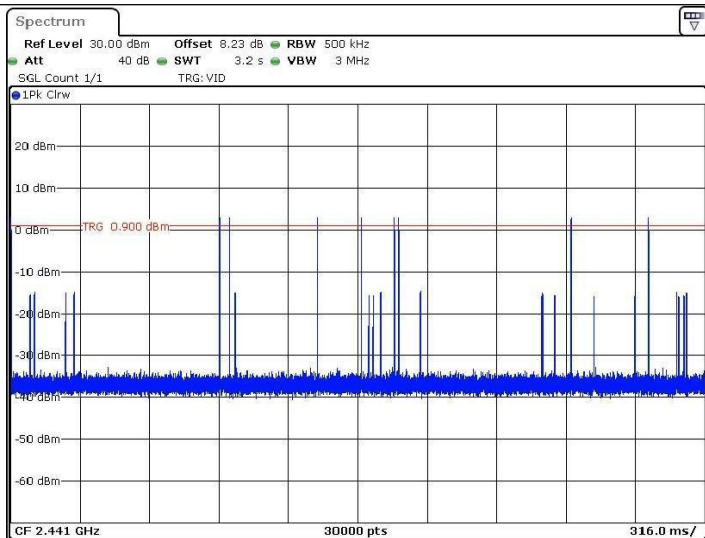


Date: 8 MAR 2023 05:51:25

2DH5_Ant1_Hop

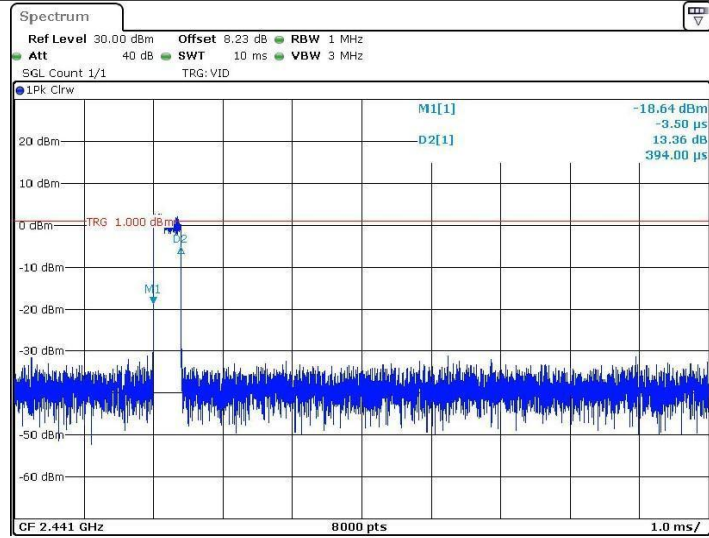


Date: 8 MAR 2023 04:28:53

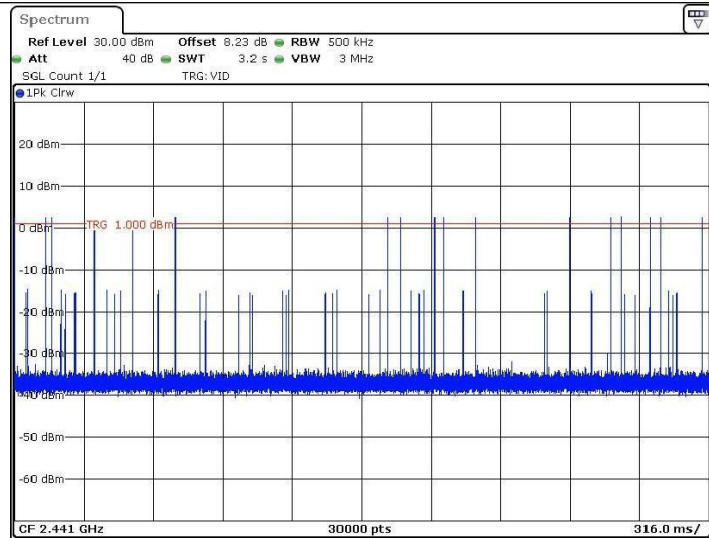


Date: 8 MAR 2023 04:28:59

3DH1_Ant1_Hop

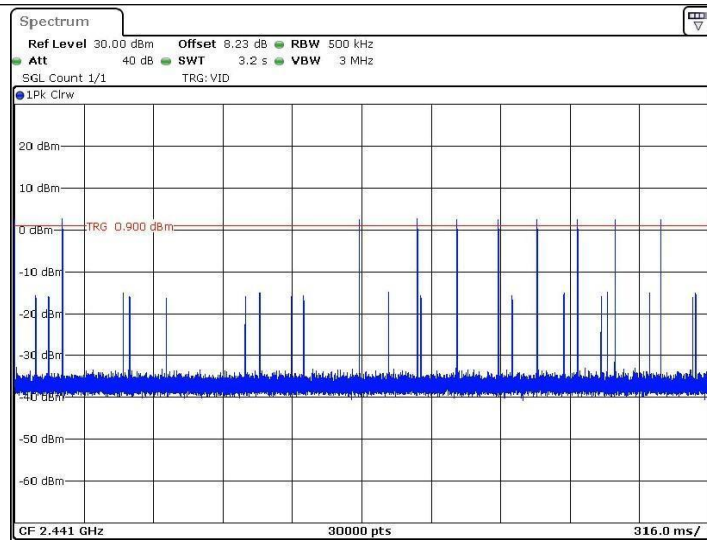
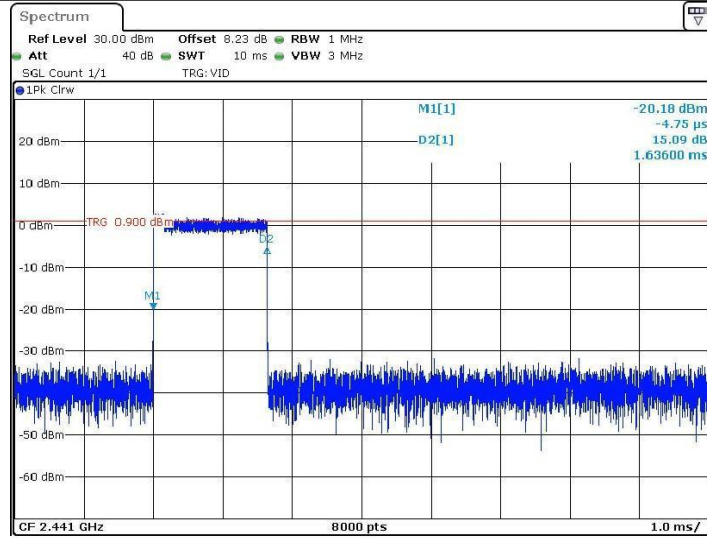


Date: 8 MAR 2023 06:02:13

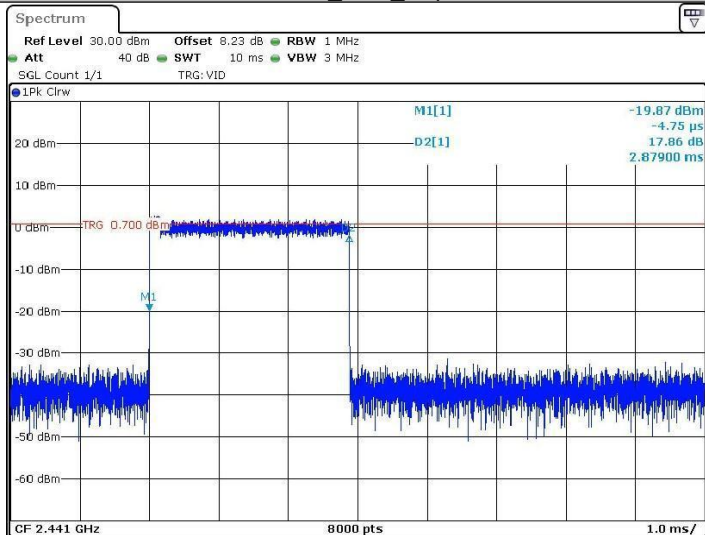


Date: 8 MAR 2023 06:02:19

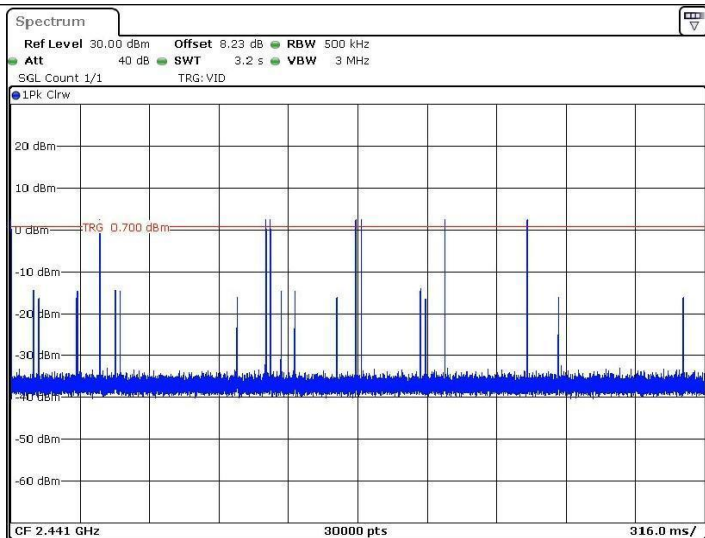
3DH3_Ant1_Hop



3DH5_Ant1_Hop

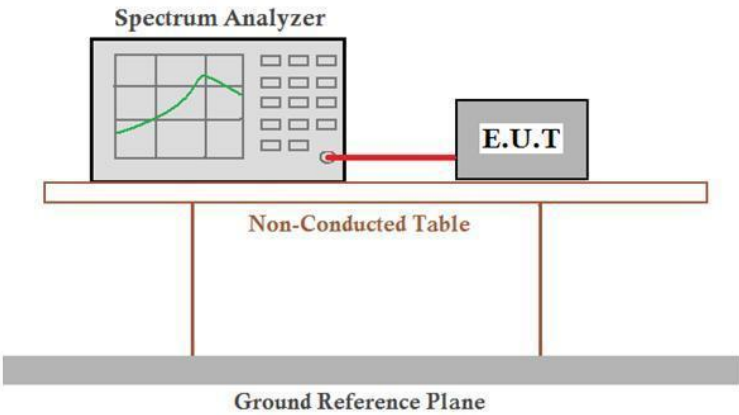


Date: 8 MAR 2023 05:58:48



Date: 8 MAR 2023 05:58:54

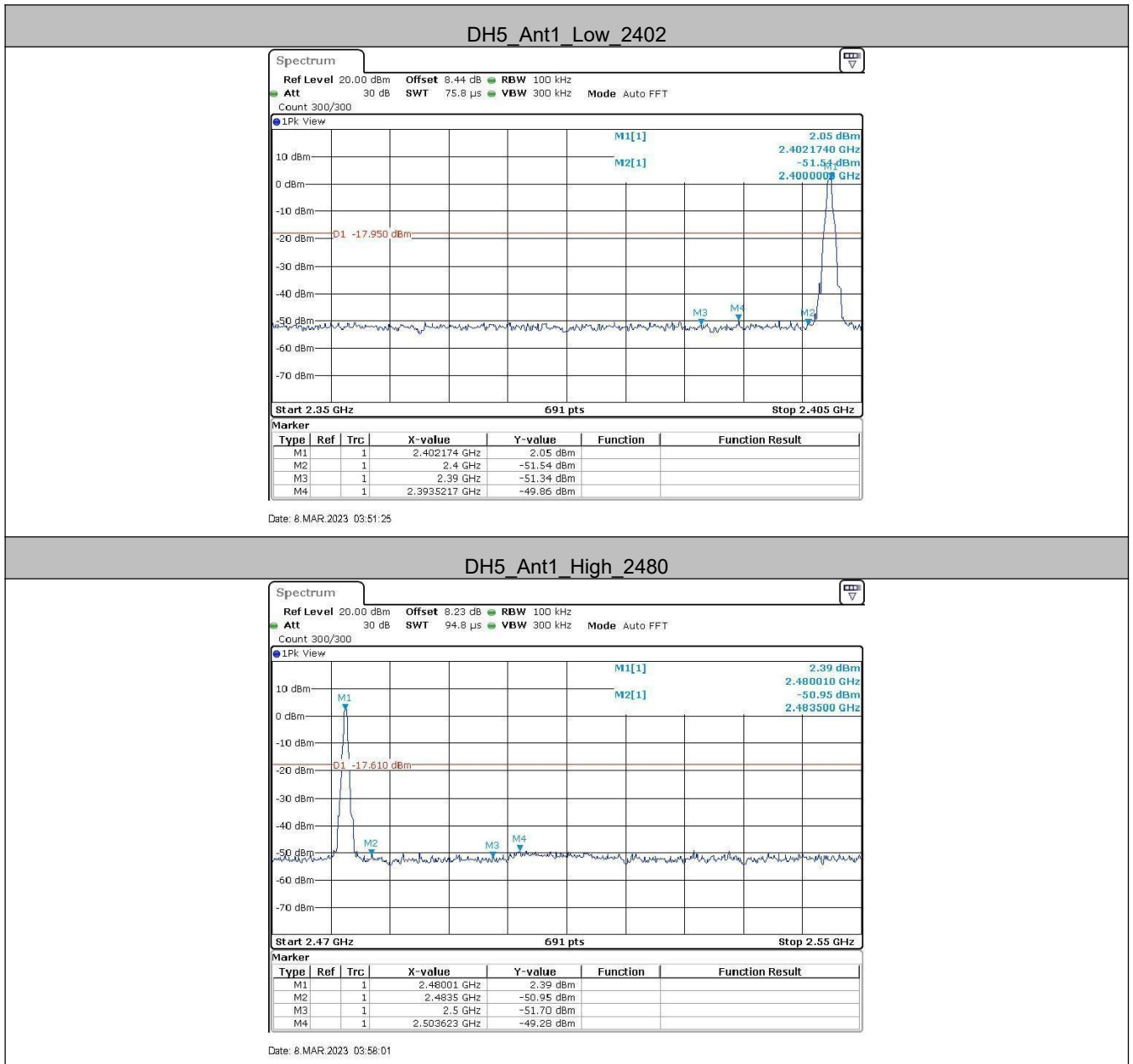
5.8 Band-edge for RF Conducted Emissions

Test Requirement:	47 CFR Part 15C Section 15.247 (d)
Test Method:	ANSI C63.10:2013
Test Setup:	 <i>Remark: Offset=cable loss+ attenuation factor.</i>
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.
Exploratory Test Mode:	Hopping and Non-hopping transmitting with all kind of modulation and all kind of data type
Final Test Mode:	Through Pre-scan, find the DH5 of data type is the worst case of GFSK modulation type, 2-DH5 of data type is the worst case of $\pi/4$ DQPSK modulation type, 3-DH5 of data type is the worst case of 8DPSK modulation type. Only the worst case is recorded in the report.
Test Results:	Pass

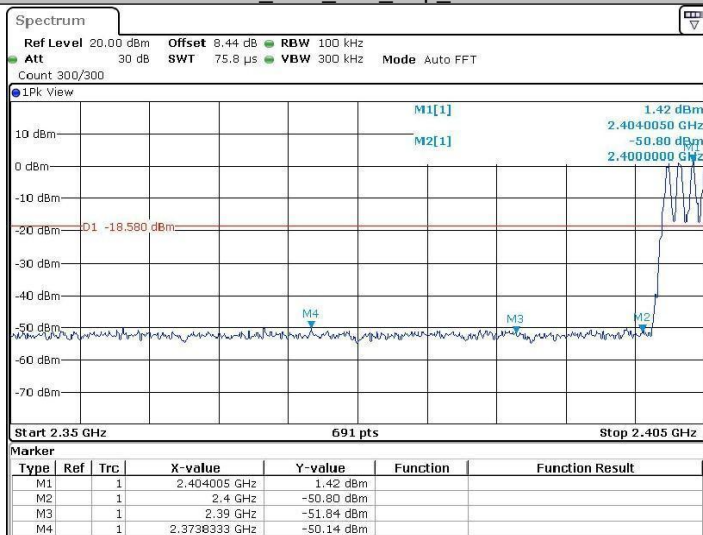
Measurement Data

TestMode	Antenna	ChName	Freq(MHz)	RefLevel [dBm]	Result [dBm]	Limit [dBm]	Verdict
DH5	Ant1	Low	2402	2.05	-49.86	≤-17.95	PASS
		High	2480	2.39	-49.28	≤-17.61	PASS
		Low	Hop_2402	1.42	-50.14	≤-18.58	PASS
		High	Hop_2480	2.83	-48.44	≤-17.17	PASS
2DH5	Ant1	Low	2402	1.90	-49.56	≤-18.1	PASS
		High	2480	2.32	-49.2	≤-17.68	PASS
		Low	Hop_2402	1.85	-50.26	≤-18.15	PASS
		High	Hop_2480	1.95	-48.79	≤-18.05	PASS
3DH5	Ant1	Low	2402	2.01	-49.77	≤-17.99	PASS
		High	2480	2.15	-49.52	≤-17.85	PASS
		Low	Hop_2402	-1.25	-50.19	≤-21.25	PASS
		High	Hop_2480	2.15	-49.25	≤-17.85	PASS

Test plot as follows:

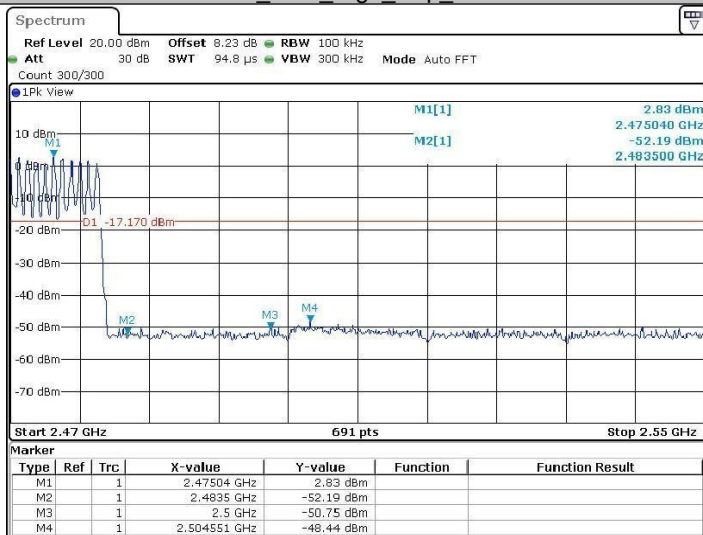


DH5_Ant1_Low_Hop_2402



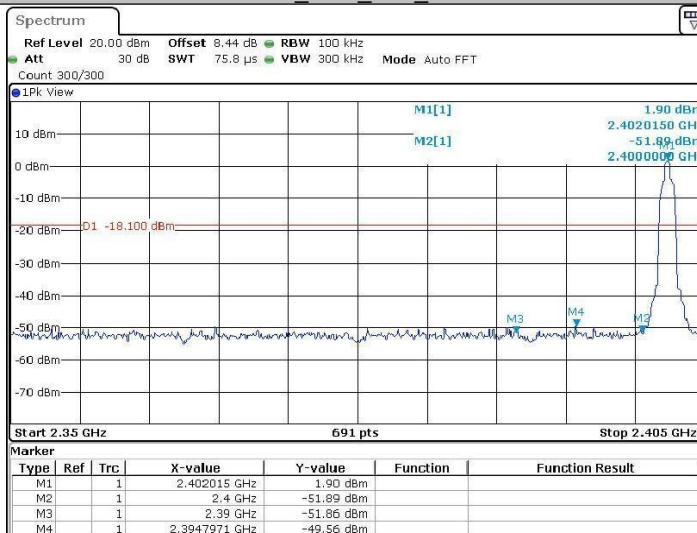
Date: 8 MAR 2023 04:17:55

DH5_Ant1_High_Hop_2480



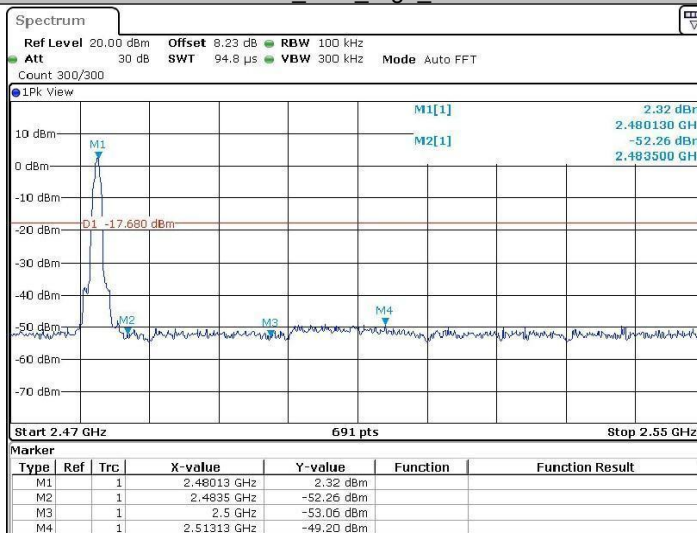
Date: 8 MAR 2023 04:24:05

2DH5_Ant1_Low_2402



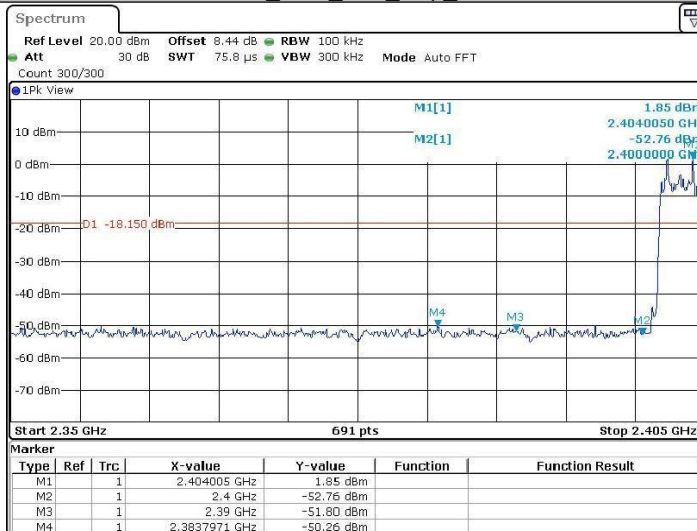
Date: 8 MAR 2023 04:02:29

2DH5_Ant1_High_2480



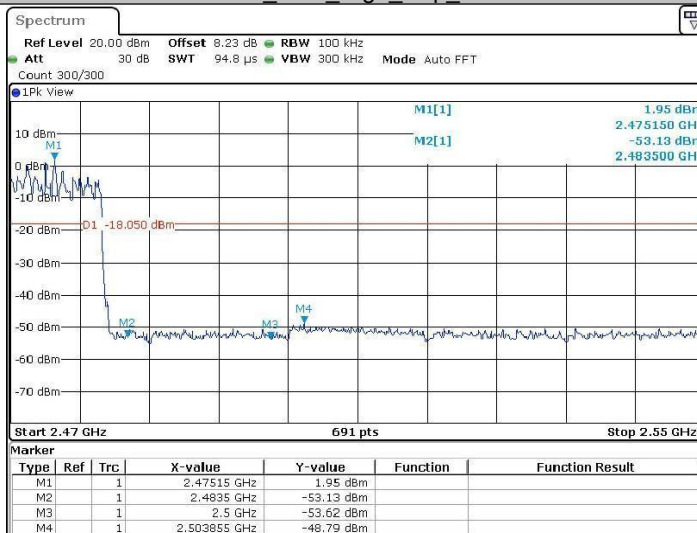
Date: 8 MAR 2023 04:07:17

2DH5_Ant1_Low_Hop_2402



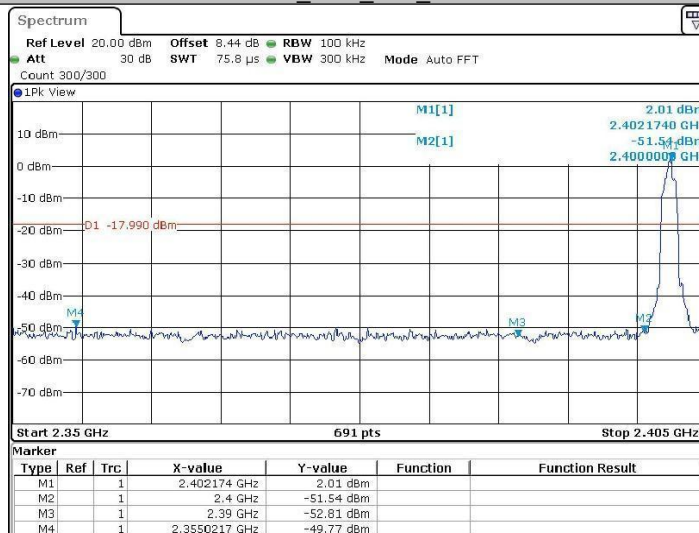
Date: 8 MAR 2023 04:25:16

2DH5_Ant1_High_Hop_2480



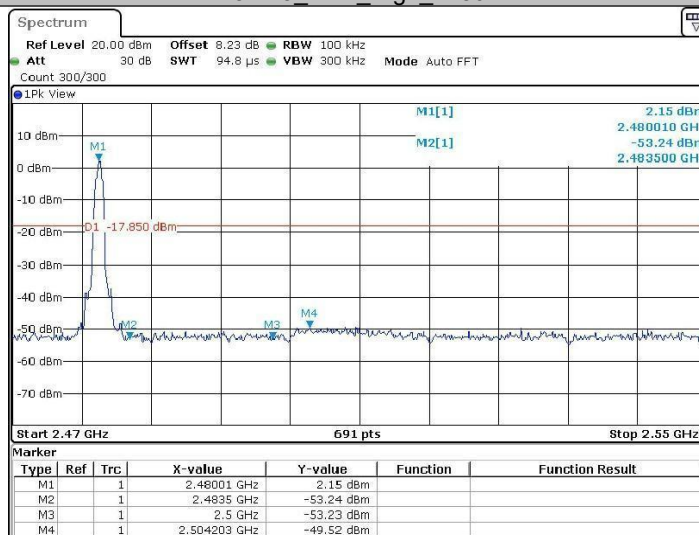
Date: 8 MAR 2023 05:52:33

3DH5_Ant1_Low_2402



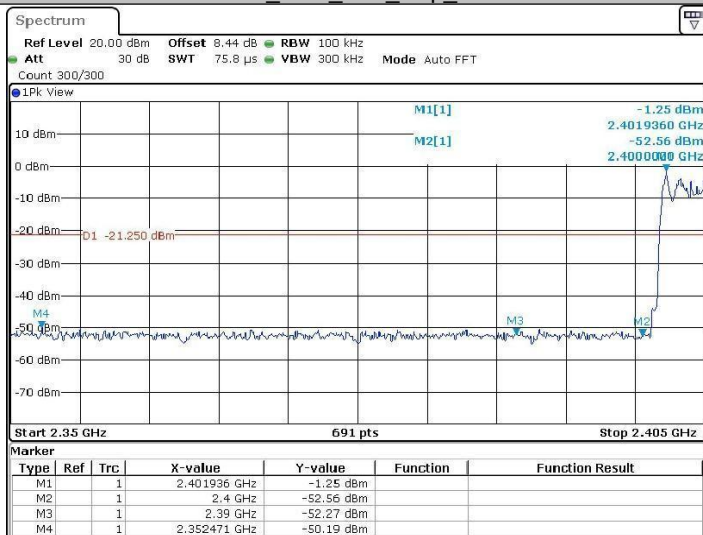
Date: 8 MAR 2023 04:09:44

3DH5_Ant1_High_2480



Date: 8 MAR 2023 04:16:00

3DH5_Ant1_Low_Hop_2402



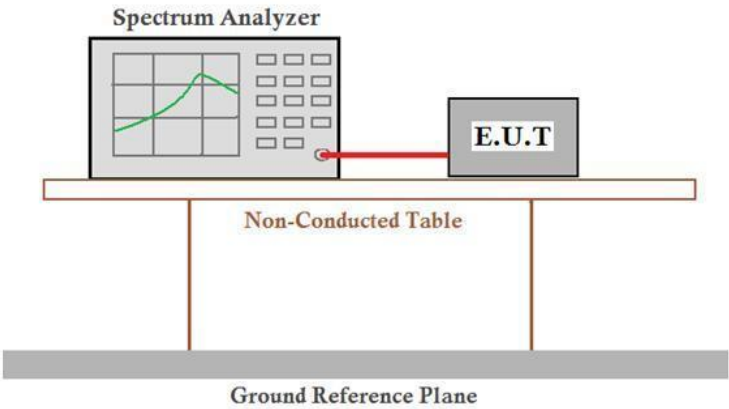
Date: 8 MAR 2023 05:54:12

3DH5_Ant1_High_Hop_2480



Date: 8 MAR 2023 06:04:27

5.9 Spurious RF Conducted Emissions

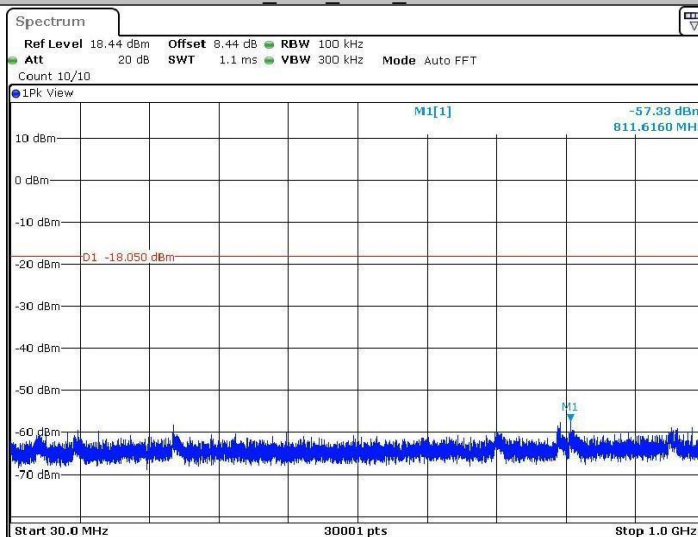
Test Requirement:	47 CFR Part 15C Section 15.247 (d)
Test Method:	ANSI C63.10:2013
Test Setup:	 <i>Remark: Offset=cable loss+ attenuation factor.</i>
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.
Exploratory Test Mode:	Non-hopping transmitting with all kind of modulation and all kind of data type
Final Test Mode:	Through Pre-scan, find the DH5 of data type is the worst case of GFSK modulation type, 2-DH5 of data type is the worst case of $\pi/4$ DQPSK modulation type, 3-DH5 of data type is the worst case of 8DPSK modulation type.
Test Results:	Pass

DH5_Ant1_2402_0~Reference



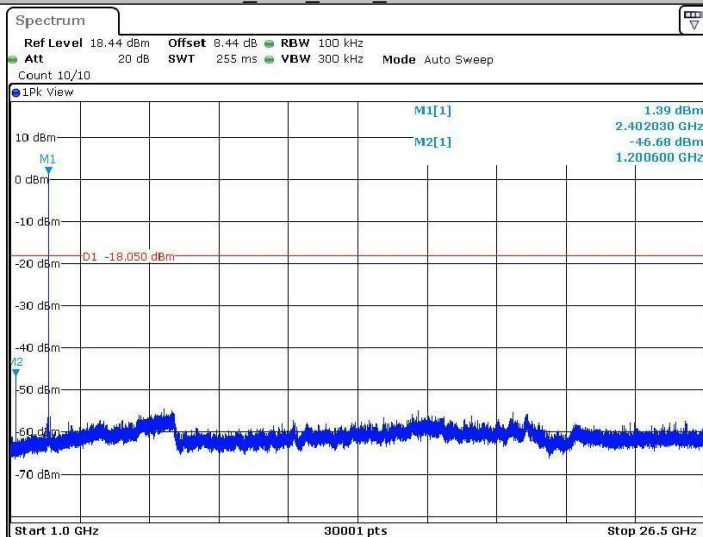
Date: 8 MAR 2023 03:52:30

DH5_Ant1_2402_30~1000



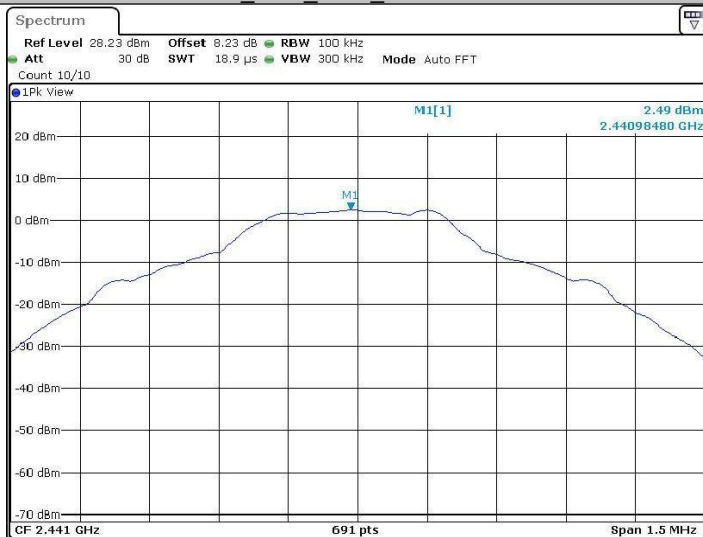
Date: 8 MAR 2023 03:52:36

DH5_Ant1_2402_1000~26500



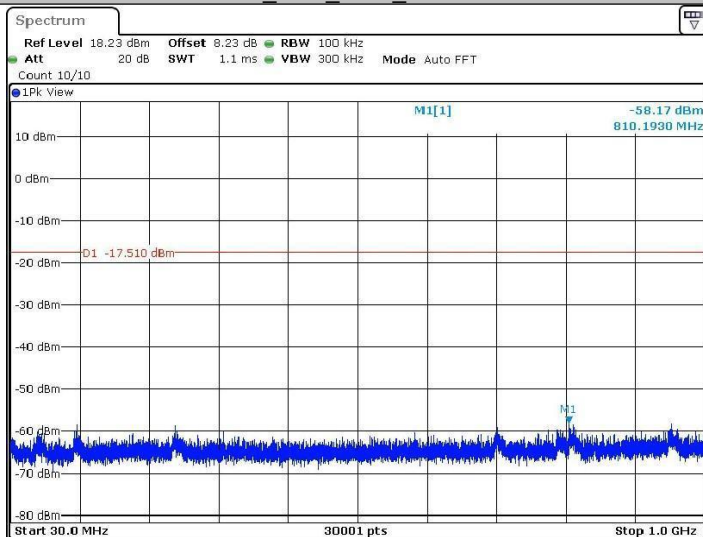
Date: 8 MAR 2023 03:52:59

DH5_Ant1_2441_0~Reference



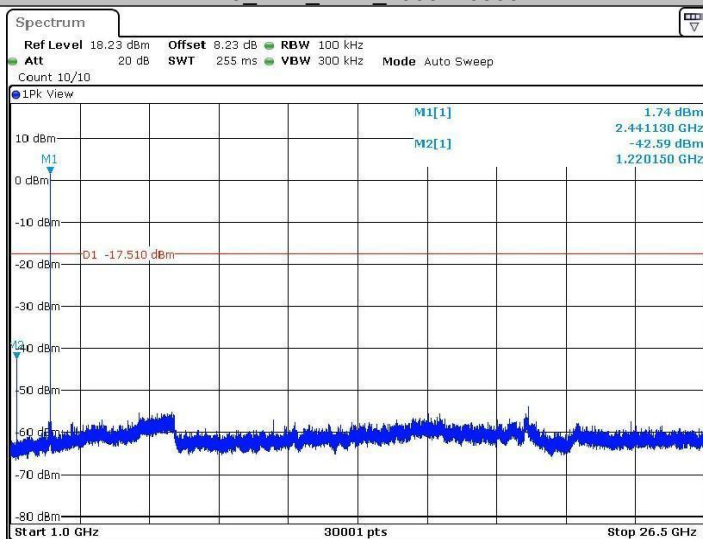
Date: 8 MAR 2023 03:53:49

DH5_Ant1_2441_30~1000



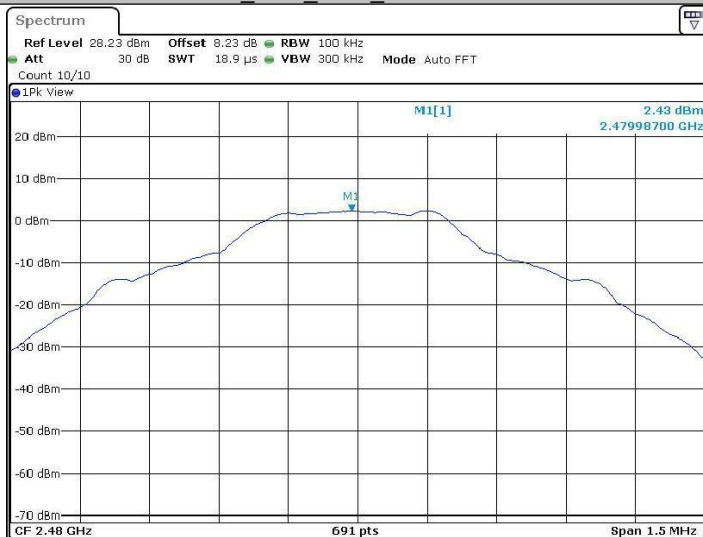
Date: 8 MAR 2023 03:53:55

DH5_Ant1_2441_1000~26500



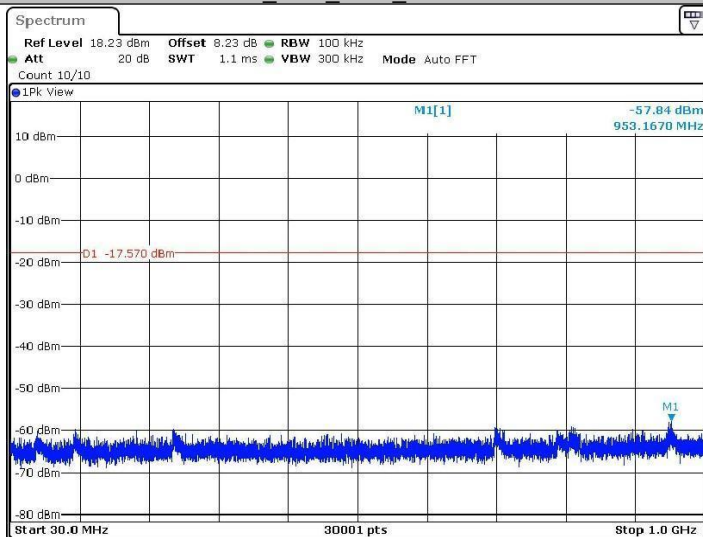
Date: 8 MAR 2023 03:54:17

DH5_Ant1_2480_0~Reference



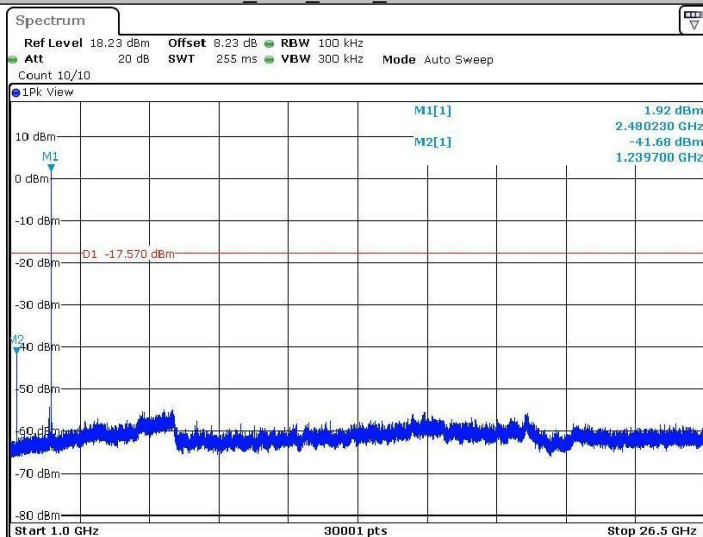
Date: 8 MAR 2023 03:58:06

DH5_Ant1_2480_30~1000



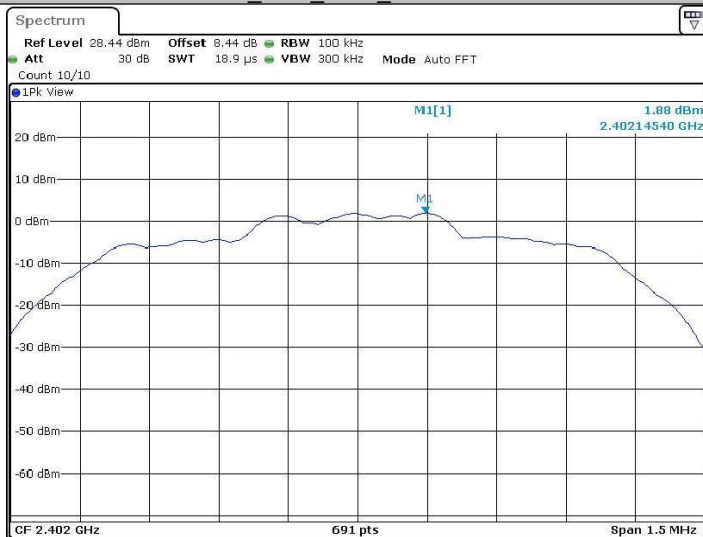
Date: 8 MAR 2023 03:58:13

DH5_Ant1_2480_1000~26500



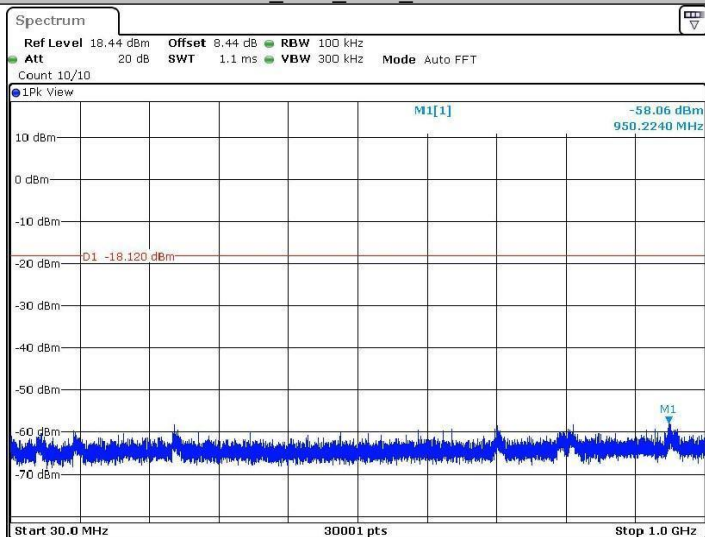
Date: 8 MAR 2023 03:59:35

2DH5_Ant1_2402_0~Reference



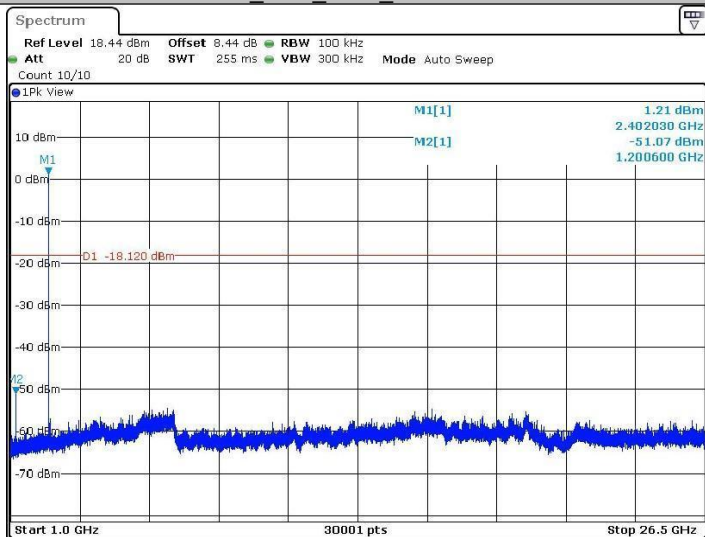
Date: 8 MAR 2023 04:03:34

2DH5_Ant1_2402_30~1000



Date: 8 MAR 2023 04:03:41

2DH5_Ant1_2402_1000~26500



Date: 8 MAR 2023 04:04:03